When placing a mandatory classification in a USPC subclass having a title beginning with "(E)," a cross-reference classification is normally made in at least one of the appended E-subclasses.

1 **(E) BULK EFFECT DEVICE**
2 .(E) Bulk effect switching in amorphous material
3 ..(E) With means to localize region of conduction (e.g., "pore" structure)
4 ..(E) With specified electrode composition or configuration
5 ..(E) In array
6 .(E) Intervalley transfer (e.g., Gunn effect)
7 ..(E) In monolithic integrated circuit
8 ..(E) Three or more terminal device
9 **(E) THIN ACTIVE PHYSICAL LAYER WHICH IS (1) AN ACTIVE POTENTIAL WELL LAYER THIN ENOUGH TO ESTABLISH DISCRETE QUANTUM ENERGY LEVELS OR (2) AN ACTIVE BARRIER LAYER THIN ENOUGH TO PERMIT QUANTUM MECHANICAL TUNNELING OR (3) AN ACTIVE LAYER THIN ENOUGH TO PERMIT CARRIER TRANSMISSION WITH SUBSTANTIALLY NO SCATTERING (E.G., SUPERLATTICE, QUANTUM WELL, OR BALLISTIC TRANSPORT DEVICE)**
10 .Low workfunction layer for electron emission, e.g., photocathode electron emissive layer
11 ..Combined with a heterojunction involving a III-V compound
12 .(E) Heterojunction
13 ..(E) Incoherent light emitter
14 ..(E) Quantum well
15 ...(E) Superlattice
16 ....(E) Of amorphous semiconductor material
17 ....(E) With particular barrier dimension
18 ....(E) Strained layer superlattice
19 .....(E) Si Ge
20 ....(E) Field effect device
21 ....(E) Light responsive structure
22 ....(E) With specified semiconductor materials
23 ...(E) Current flow across well
24 ...(E) Field effect device
25 ...(E) Employing resonant tunneling
26 ..(E) Ballistic transport device
27 ...(E) Field effect transistor
28 .Non-heterojunction superlattice (e.g., doping superlattice or alternating metal and insulator layers)
29 .Ballistic transport device (e.g., hot electron transistor)
30 .Tunneling through region of reduced conductivity
31 ..Josephson
32 ...Particular electrode material
33 ....High temperature (i.e., >30 Kelvin)
34 ...Weak link (e.g., narrowed portion of superconductive line)
35 ...Particular barrier material
36 ...With additional electrode to control conductive state of Josephson junction
37 ..At least one electrode layer of semiconductor material
38 ...Three or more electrode device
39 ..Three or more electrode device
40 **(E) ORGANIC SEMICONDUCTOR MATERIAL**
41 **(E) POINT CONTACT DEVICE**
42 **(E) SEMICONDUCTOR IS SELENIUM OR TELLURIUM IN ELEMENTAL FORM**
43 **(E) SEMICONDUCTOR IS AN OXIDE OF A METAL (E.G., CUO, ZNO) OR COPPER SULFIDE**
44 **WITH METAL CONTACT ALLOYED TO ELEMENTAL SEMICONDUCTOR TYPE PN JUNCTION IN NONREGENERATIVE STRUCTURE**
45 .Elongated alloyed region (e.g., thermal gradient zone melting, TGZM)
46 .In pn junction tunnel diode (Esaki diode)
47 .In bipolar transistor structure

48 **TEST OR CALIBRATION STRUCTURE**
49 **(E) NON-SINGLE CRYSTAL, OR RECRYSTALLIZED, SEMICONDUCTOR MATERIAL FORMS PART OF ACTIVE JUNCTION (INCLUDING FIELD-INDUCED ACTIVE JUNCTION)**
50 .Non-single crystal, or recrystallized, active junction adapted to be electrically shorted (e.g., "anti-fuse" element)
51 .(E) Non-single crystal, or recrystallized, material forms active junction with single crystal material (e.g., monocrystal to polycrystal pn junction or heterojunction)
52 .(E) Amorphous semiconductor material
53 ..(E) Responsive to nonelectrical external signals (e.g., light)
54 ...(E) With Schottky barrier to amorphous material
55 ...(E) Amorphous semiconductor is alloy or contains material to change band gap (e.g., Si Ge , SiN)
56 ...With impurity other than hydrogen to passivate dangling bonds (e.g., halide)
57 ..Field effect device in amorphous semiconductor material
58 ...With impurity other than hydrogen to passivate dangling bonds (e.g., halide)
59 ...(E) In array having structure for use as imager or display, or with transparent electrode
60 ...With field electrode under or on a side edge of amorphous semiconductor material (e.g., vertical current path)
61 ...With heavily doped regions contacting amorphous semiconductor material (e.g., heavily doped source and drain)
62 ..With impurity other than hydrogen to passivate dangling bonds (e.g., halide)
63 ..(E) Amorphous semiconductor is alloy or contains material to change band gap (e.g., SixGe1-x, SiNy)
64 .(E) Non-single crystal, or recrystallized, material with specified crystal structure (e.g., specified crystal size or orientation)
65 .Non-single crystal, or recrystallized, material containing non-dopant additive, or alloy of semiconductor materials (e.g., GexSi1-x, polycrystalline silicon with dangling bond modifier)
66 .(E) Field effect device in non-single crystal, or recrystallized, semiconductor material
67 ..(E) In combination with device formed in single crystal semiconductor material (e.g., stacked FETs)
68 ...Capacitor element in single crystal semiconductor (e.g., DRAM)
69 ...Field effect transistor in single crystal material, complememtary to that in non-single crystal, or recrystallized, material (e.g., CMOS)
70 ...Recrystallized semiconductor material
71 ..In combination with capacitor element (e.g., DRAM)
72 ..(E) In array having structure for use as imager or display, or with transparent electrode
73 .Schottky barrier to polycrystalline semiconductor material
74 .Plural recrystallized semiconductor layers (e.g., "3-dimensional integrated circuit")
75 .Recrystallized semiconductor material
76 **(E) SPECIFIED WIDE BAND GAP (> 1.5EV) SEMICONDUCTOR MATERIAL OTHER THAN GAASP OR GAALAS**
77 .(E) Diamond or Silicon Carbide
78 .(E) II-IV compound
79 **(E) INCOHERENT LIGHT EMITTER STRUCTURE**

80 .In combination with or also constituting light responsive device
81 ..With specific housing or contact structure
82 ...Discrete light emitting and light responsive devices
83 ..Light coupled transistor structure
84 ..Combined in integrated structure
85 ...With heterojunction
86 .Active layer of indirect band gap semiconductor
87 ..With means to facilitate electron-hole recombination (e.g., isoelectronic traps such as nitrogen in GaP)
88 .(E) Plural light emitting devices (e.g., matrix, 7-segment array)
89 ..(E) Multi-color emission
90 ...(E) With heterojunction
91 ..(E) With shaped contacts or opaque masking
92 ..(E) Alphanumeric segmented array
93 ..(E) With electrical isolation means in integrated circuit structure
94 .With heterojunction
95 ..With contoured external surface (e.g., dome shape to facilitate light emission)
96 ..(E) Plural heterojunctions in same device
97 ...(E) More than two heterojunctions in same device
98 .(E) With reflector, opaque mask, or optical element (e.g., lens, optical fiber, index of refraction matching layer, luminescent material layer, filter) integral with device or device enclosure or package
99 .(E) With housing or contact structure
100 .(E) Encapsulated
101 .(E) With particular dopant concentration or concentration profile (e.g., graded junction)
102 .(E) With particular dopant material (e.g., Zinc as dopant in GaAs)
103 .(E) With particular semiconductor material
104 **(E) TUNNELING PN JUNCTION (E.G., ESAKI DIODE) DEVICE**
105 .In three or more terminal device
106 .(E) Reverse bias tunneling structure (e.g., "backward" diode, true Zener diode)
107 **(E) REGENERATIVE TYPE SWITCHING DEVICE (E.G., SCR, COMFET, THYRISTOR)**
108 .Controlled by nonelectrical, nonoptical external signal (e.g., magnetic field, pressure, thermal)
109 .Having only two terminals and no control electrode (gate) (e.g., Shockley diode)
110 ..More than four semiconductor layers of alternating conductivity types (e.g., pnpnpn structure, 5 layer bidirectional diacs, etc.)
111 ..Triggered by VBO overvoltage means
112 ..(E) With highly-doped breakdown diode trigger
113 .With light activation
114 ..(E) With separate light dector integrated on chip with regenerative switching device
115 ..(E) With electrical trigger signal amplification means (e.g., amplified gate, "pilot thyristor", etc.)
116 ..(E) With light conductor means (e.g., light fiber or light pipe) integral with device or device enclosure or package
117 ...(E) In groove or with thinned semiconductor portion
118 ..(E) With groove or thinned light sensitive portion
119 .(E) Bidirectional rectifier with control electrode (gate) (e.g., Triac)
120 ..Six or more semiconductor layers of alternating conductivity types (e.g., npnpnpn structure)
121 ..(E) With diode or transistor in reverse path
122 ..(E) Lateral

123 ..(E) With trigger signal amplification (e.g., amplified gate)
124 ..(E) Combined with field effect transistor structure
125 ...(E) Controllable emitter shunting
126 ..With means to separate a device into sections having different conductive polarity
127 ...Guard ring or groove
128 ..Having overlapping sections of different conductive polarity
129 ..With means to increase reverse breakdown voltage
130 ..Switching speed enhancement means
131 ...Recombination centers or deep level dopants
132 .Five or more layer unidirectional structure
133 .(E) Combined with field effect transistor
134 ..(E) J-FET (junction field effect transistor)
135 ...(E) Vertical (i.e., where the source is located above the drain or vice versa)
136 ....(E) Enhancement mode (e.g., so-called SITs)
137 ..(E) Having controllable emitter shunt
138 ...(E) Having gate turn off (GTO) feature
139 ..(E) With extended latchup current level (e.g., COMFET device)
140 ...(E) Combined with other solid state active device in integrated structure
141 ...(E) Lateral structure, i.e., current flow parallel to main device surface
142 ...(E) Having impurity doping for gain reduction
143 ...(E) Having anode shunt means
144 ...(E) Cathode emitter or cathode electrode feature
145 ...(E) Low impedance channel contact extends below surface
146 .(E) Combined with other solid state active device in integrated structure
147 .(E) With extended latchup current level (e.g., gate turn off "GTO" device)
148 ..Having impurity doping for gain reduction
149 ..Having anode shunt means
150 ..With specified housing or external terminal
151 ...External gate terminal structure or composition
152 ..Cathode emitter or cathode electrode feature
153 ..Gate region or electrode feature
154 .(E) With resistive region connecting separate sections of device
155 .With switching speed enhancement means (e.g., Schottky contact)
156 ..Having deep level dopants or recombination centers
157 .(E) With integrated trigger signal amplification means (e.g., amplified gate, "pilot thyristor", etc.)
158 ..(E) Three or more amplification stages
159 ..(E) Transistor as amplifier
160 ..(E) With distributed amplified current
161 ..(E) With a turn-off diode
162 .Lateral structure
163 .Emitter region feature
164 ..Multi-emitter region (e.g., emitter geometry or emitter ballast resistor)
165 ...Laterally symmetric regions
166 ...Radially symmetric regions
167 .Having at least four external electrodes
168 .With means to increase breakdown voltage
169 ..High resistivity base layer
170 ..Surface feature (e.g., guard ring, groove, mesa)
171 ...Edge feature (e.g., beveled edge)
172 .With means to lower "ON" voltage drop
173 .(E) Device protection (e.g., from overvoltage)
174 ..Rate of rise of current (e.g., dI/dt)

175 .With means to control triggering (e.g., gate electrode configuration, zener diode firing, dV/dt control, transient control by ferrite bead, etc.)
176 ..Located in an emitter-gate region
177 .With housing or external electrode
178 ..With means to avoid stress between electrode and active device (e.g., thermal expansion matching of electrode to semiconductor)
179 ...With malleable electrode (e.g., silver electrode layer)
180 ..Stud mount
181 ..With large area flexible electrodes in press contact with opposite sides of active semiconductor chip and surrounded by an insulating element (e.g., ring)
182 ...With lead feedthrough means on side of housing
183 **(E) HETEROJUNCTION DEVICE**
183.1 .Charge transfer device
184 .(E) Light responsive structure
185 ..(E) Staircase (including graded composition) device
186 ..(E) Avalanche photodetection structure
187 ..(E) Having transistor structure
188 ..(E) Having narrow energy band gap (<<1eV) layer (e.g., PbSnTe, HgCdTe, etc.)
189 ...(E) Layer is a group III-V semiconductor compound
190 .With lattice constant mismatch (e.g., with buffer layer to accomodate mismatch)
191 .Having graded composition
192 .(E) Field effect transistor
194 ..(E) Doping on side of heterojunction with lower carrier affinity (e.g., high electron mobility transistor (HEMT)
195 ...(E) Combined with diverse type device
196 .Both semiconductors of the heterojunction are the same conductivity type (i.e., either N or P)
197 .(E) Bipolar transistor
198 ..Wide band gap emitter
199 .(E) Avalanche diode (e.g., so-called "Zener" diode having breakdown voltage greater than 6 volts, including heterojunction IMPATT type microwave diodes)
200 .(E) Heterojunction formed between semiconductor materials which differ in that they belong to different periodic table groups (e.g., Ge (group IV) - GaAs (group III-V) or InP (group III-V) - CdTe (group II-VI))
201 .(E) Between different group IV-VI or II-VI or III-V compounds other than GaAs/GaAlAs
202 **(E) GATE ARRAYS**
203 .(E) With particular chip input/output means
204 .(E) Having specific type of active device (e.g., CMOS)
205 ..(E) With bipolar transistors or with FETs of only one channel conductivity type (e.g., enhancement-depletion FETs)
206 ..(E) Particular layout of complementary FETs with regard to each other
207 .(E) With particular power supply distribution means
208 .(E) With particular signal path connections
209 ..(E) Programmable signal paths (e.g., with fuse elements, laser programmable, etc.)
210 ..(E) With wiring channel area
211 ..(E) Multi-level metallization
212 **(E) CONDUCTIVITY MODULATION DEVICE (E.G., UNIJUNCTION TRANSISTOR, DOUBLE-BASE DIODE, CONDUCTIVITY-MODULATED TRANSISTOR)**
213 **(E) FIELD EFFECT DEVICE**
214 .(E) Charge injection device
215 .(E) Charge transfer device
216 ..(E) Majority signal carrier (e.g., buried or bulk channel, or peristaltic)
217 ...(E) Having a conductive means in direct contact with channel (e.g., non-insulated gate)

218 ...(E) High resistivity channel (e.g., accumulation mode) or surface channel (e.g., transfer of signal charge occurs at the surface of the semi-conductor) or minority carriers at input (e.g., surface channel input)
219 ...Impurity concentration variation
220 ....Vertically within channel (e.g., profiled)
221 ....Along the length of the channel (e.g., doping variations for transfer directionality)
222 ...(E) Responsive to non-electrical external signal (e.g., imager)
223 ....(E) Having structure to improve output signal (e.g., antiblooming drain)
224 ...Channel confinement
225 ..(E) Non-electrical input responsive (e.g., light responsive imager, input programmed by size of storage sites for use as a read-only memory, etc.)
226 ...(E) Sensor element and charge transfer device are of different materials or on different substrates (e.g., "hybrid")
227 ...(E) With specified dopant (e.g., photoionizable, "extrinsic" detectors for infrared)
228 ...(E) Light responsive, back illuminated
229 ...(E) Having structure to improve output signal (e.g., exposure control structure)
230 ....(E) With blooming suppression structure
231 ...(E) 2-dimensional area architecture
232 ....(E) Having alternating strips of sensor structures and register structures (e.g., interline imager)
233 ....(E) Sensors not overlaid by electrode (e.g., photodiodes)
234 ...(E) Single strip sensors (e.g., linear imager)
235 ..Electrical input
236 ...Signal applied to field effect electrode
237 ....Charge-presetting/linear input type (e.g., fill and spill)
238 ...Input signal responsive to signal charge in charge transfer device (e.g., regeneration or feedback)
239 ..Signal charge detection type (e.g., floating diffusion or floating gate non-destructive output)
240 ..Changing width or direction of channel (e.g., meandering channel)
241 ..Multiple channels (e.g., converging or diverging or parallel channels)
242 ..Vertical charge transfer
243 ..Channel confinement
244 ..Comprising a groove
245 ..Structure for applying electric field into device (e.g., resistive electrode, acoustic traveling wave in channel)
246 ...Phase structure (e.g., doping variations to provide asymmetry for 2-phase operation; more than four phases or "electrode per bit")
247 ....Uniphase or virtual phase structure
248 ....(E) 2-phase
249 ...Electrode structures or materials
250 ....Plural gate levels
251 ..(E) Substantially incomplete signal charge transfer (e.g., bucket brigade)
252 .Responsive to non-optical, non-electrical signal
253 ..Chemical (e.g., ISFET, CHEMFET)
254 ..Physical deformation (e.g., strain sensor, acoustic wave detector)
255 .With current flow along specified crystal axis (e.g., axis of maximum carrier mobility)
256 .(E) Junction field effect transistor (unipolar transistor)

257 ..(E) Light responsive or combined with light responsive device
258 ...(E) In imaging array
259 ..Elongated active region acts as transmission line or distributed active element (e.g., "transmission line" field effect transistor)
260 ..Same channel controlled by both junction and insulated gate electrodes, or by both Schottky barrier and pn junction gates (e.g., "taper isolated" memory cell)
261 ..Junction gate region free of direct electrical connection (e.g., floating junction gate memory cell structure)
262 ..(E) Combined with insulated gate field effect transistor (IGFET)
263 ..Vertical controlled current path
264 ...Enhancement mode or with high resistivity channel (e.g., doping of 1015cm-3 or less)
265 ...(E) In integrated circuit
266 ...(E) With multiple parallel current paths (e.g., grid gate)
267 ....(E) With Schottky barrier gate
268 ..Enhancement mode
269 ...With means to adjust barrier height (e.g., doping profile)
270 ..Plural, separately connected, gates control same channel region
271 ..(E) Load element or constant current source (e.g., with source to gate connection)
272 ..(E) Junction field effect transistor in integrated circuit
273 ...(E) With bipolar device
274 ...(E) Complementary junction field effect transistors
275 ...(E) Microwave integrated circuit (e.g., microstrip type)
276 ....(E) With contact or heat sink extending through hole in semiconductor substrate, or with electrode suspended over substrate (e.g., air bridge)
277 ....(E) With capacitive or inductive elements
278 ...(E) With devices vertically spaced in different layers of semiconductor material (e.g., "3-dimensional" integrated circuit)
279 ..Pn junction gate in compound semiconductor material (e.g., GaAs)
280 ..With Schottky gate
281 ...Schottky gate to silicon semiconductor
282 ...Gate closely aligned to source region
283 ....With groove or overhang for alignment
284 ...Schottky gate in groove
285 ..With profiled channel dopant concentration or profiled gate region dopant concentration (e.g., maximum dopant concentration below surface)
286 ..With non-uniform channel thickness or width
287 ..With multiple channels or chanel segments connected in parallel, or with channel much wider than length between source and drain (e.g., power JFET)
288 .(E) Having insulated electrode (e.g., MOSFET, MOS diode)
289 ..(E) Significant semiconductor chemical compound in bulk crystal (e.g., GaAs)
290 ..(E) Light responsive or combined with light responsive device
291 ...(E) Imaging array
292 ....(E) Photodiodes accessed by FETs
293 ....(E) Photoresistors accessed by FETs, or photodetectors separate from FET chip
294 ....(E) With shield, filter, or lens
295 ..(E) With ferroelectric material layer
296 ..(E) Insulated gate capacitor or insulated gate transistor combined with capacitor (e.g., dynamic memory cell)

297 ...With means for preventing charge leakage due to minority carrier generation (e.g., alpha generated soft error protection or "dark current" leakage protection)
298 ...(E) Capacitor for signal storage in combination with non-volatile storage means
299 ...(E) Structure configured for voltage converter (e.g., charge pump, substrate bias generator)
300 ...Capacitor coupled to, or forms gate of, insulated gate field effect transistor (e.g., nondestructive readout dynamic memory cell structure)
301 ...Capacitor in trench
302 ....Vertical transistor
303 ....Stacked capacitor
304 ....Storage node isolated by dielectric from semiconductor substrate
305 ....With means to insulate adjacent storage nodes (e.g., channel stops or field oxide)
306 ...Stacked capacitor
307 ....Parallel interleaved capacitor electrode pairs (e.g., interdigitized)
308 .....With capacitor electrodes connection portion located centrally thereof (e.g., fin electrodes with central post)
309 ....With increased effective electrode surface area (e.g., tortuous path, corrugated, or textured electrodes)
310 ...With high dielectric constant insulator (e.g., Ta2Os)
311 ...Storage node isolated by dielectric from semiconductor substrate
312 ...Voltage variable capacitor (i.e., capacitance varies with applied voltage)
313 ...Inversion layer capacitor
314 ..Variable threshold (e.g., floating gate memory device)
315 ...(E) With floating gate electrode
316 ....With additional contacted control electrode
317 .....With irregularities on electrode to facilitate charging or discharging of floating electrode
318 .....Additional control electrode is doped region in semiconductor substrate
319 .....Plural additional contacted control electrodes
320 ......Separate control electrodes for charging and for discharging floating electrode
321 .....With thin insulator region for charging or discharging floating electrode by quantum mechanical tunneling
322 .....With charging or discharging by control voltage applied to source or drain region (e.g., by avalanche breakdown of drain junction)
323 ....(E) With means to facilitate light erasure
324 ...(E) Multiple insulator layers (e.g., MNOS structure)
325 ....(E) Non-homogeneous composition insulator layer (e.g., graded composition layer or layer with inclusions)
326 ....With additional, non-memory control electrode or channel portion (e.g., accessing field effect transistor structure)
327 ..Short channel insulated gate field effect transistor
328 ...Vertical channel or double diffused insulated gate field effect device provided with means to protect against excess voltage (e.g., gate protection diode)
329 ...(E) Gate controls vertical charge flow portion of channel (e.g., VMOS device)
330 ....(E) Gate electrode in groove
331 .....Plural gate electrodes or grid shaped gate electrode
332 .....Gate electrode self-aligned with groove
333 .....With thick insulator to reduce gate capacitance in non-channel areas (e.g., thick oxide over source or drain region)

334 .....(E) In integrated circuit structure
335 ...(E) Active channel region has a graded dopant concentration decreasing with distance from source region (e.g., double diffused device, DMOS transistor)
336 ....With lightly doped portion of drain region adjacent channel (e.g., LDD structure)
337 ....(E) In integrated circuit structure
338 .....(E) With complementary field effect transistor
339 ....With means to increase breakdown voltage
340 ....With means (other than self-alignment of the gate electrode) to decrease gate capacitance (e.g., shield electrode)
341 ....(E) Plural sections connected in parallel (e.g., power MOSFET)
342 .....(E) With means to reduce ON resistance
343 ....(E) All contacts on same surface (e.g., lateral structure)
344 ...(E) With lightly doped portion of drain region adjacent channel (e.g., LDD structure)
345 ...With means to prevent sub-surface currents, or with non-uniform channel doping
346 ...Gate electrode overlaps the source or drain by no more than depth of source or drain (e.g., self-aligned gate)
347 ..(E) Single crystal semiconductor layer on insulating substrate (SOI)
348 ...(E) Depletion mode field effect transistor
349 ...With means (e.g., a buried channel stop layer) to prevent leakage current along the interface of the semiconductor layer and the insulating substrate
350 ...(E) Insulated electrode device is combined with diverse type device (e.g., complementary MOSFETs, FET with resistor, etc.)
351 ....(E) Complementary field effect transistor structures only (i.e., not including bipolar transistors, resistors, or other components)
352 ...(E) Substrate is single crystal insulator (e.g., sapphire or spinel)
353 ....Single crystal islands or semiconductor layer containing only one active device
354 .....Including means to eliminate island edge effects (e.g., insulating filling between islands, or channel stop regions in island edges)
355 ..(E) With overvoltage protective means
356 ...(E) For protecting against gate insulator breakdown
357 ....(E) In complementary field effect transistor integrated circuit
358 .....(E) Including resistor element
359 ......(E) As thin film structure (e.g., polysilicon resistor)
360 ....(E) Protection device includes insulated gate transistor structure (e.g., combined with resistor element)
361 .....(E) For operation as bipolar or punchthrough element
362 ....(E) Punchthrough or bipolar element
363 ....(E) Including resistor element
364 ..(E) With resistive gate electrode
365 ..(E) With plural, separately connected, gate electrodes in same device
366 ...(E) Overlapping gate electrodes
367 ..(E) Insulated gate controlled breakdown of pn junction (e.g., field plate diode)
368 ..(E) Insulated gate field effect transistor in integrated circuit
369 ...(E) Complementary insulated gate field effect transistors

370 ....(E) Combined with bipolar transistor
371 ....(E) Complementary transistors in wells of opposite conductivity types more heavily doped than the substrate region in which they are formed, e.g., twin wells
372 ....With means to prevent latchup or parasitic conduction channels
373 ....With pn junction to collect injected minority carriers to prevent parasitic bipolar transistor action
374 .....Dielectric isolation means (e.g., dielectric layer in vertical grooves)
375 .....With means to reduce substrate spreading resistance (e.g., heavily doped substrate)
376 .....With barrier region of reduced minority carrier lifetime (e.g., heavily doped P+ region to reduce electron minority carrier lifetime, or containing deep level impurity or crystal damage), or with region of high threshold voltage (e.g., heavily doped channel stop region)
377 ....With polysilicon interconnections to source or drain regions (e.g., polysilicon laminated with silicide)
378 ...(E) Combined with bipolar transistor
379 ...(E) Combined with passive components (e.g., resistors)
380 ....(E) Polysilicon resistor
381 ....(E) With multiple levels of polycrystalline silicon
382 ...(E) With contact to source or drain region of refractory material (e.g., polysilicon, tungsten, or silicide)
383 ....(E) Contact of refractory or platinum group metal (e.g., molybdenum, tungsten, or titanium)
384 ....(E) Including silicide
385 ....(E) Multiple polysilicon layers
386 ...With means to reduce parasitic capacitance
387 ....Gate electrode overlaps at least one of source or drain by no more than depth of source or drain (e.g., self-aligned gate)
388 .....Gate electrode consists of refractory or platinum group metal or silicide
389 ....With thick insulator over source or drain region
390 ...(E) Matrix or array of field effect transistors (e.g., array of FETs only some of which are completed, or structure for mask programmed read-only memory (ROM))
391 ....(E) Selected groups of complete field effect devices having different threshold voltages (e.g., different channel dopant concentrations)
392 ...(E) Insulated gate field effect transistors of different threshold voltages in same integrated circuit (e.g., enhancement and depletion mode)
393 ...(E) Insulated gate field effect transistor adapted to function as load element for switching insulated gate field effect transistor
394 ...With means to prevent parasitic conduction channels
395 ....Thick insulator portion
396 .....Recessed into semiconductor surface
397 ......In vertical-walled groove
398 ......Combined with heavily doped channel stop portion
399 .....Combined with heavily doped channel stop portion
400 ....With heavily doped channel stop portion
401 ...(E) With specified physical layout (e.g., ring gate, source/drain regions shared between plural FETs, plural sections connected in parallel to form power MOSFET)
402 ..With permanent threshold adjustment (e.g., depletion mode)

403 ...With channel conductivity dopant same type as that of source and drain
404 ....Non-uniform channel doping
405 ...With gate insulator containing specified permanent charge
406 ....Plural gate insulator layers
407 ...With gate electrode of controlled workfunction material (e.g., low workfunction gate material)
408 ..(E) Including lightly doped drain portion adjacent channel (e.g., lightly doped drain, LDD device)
409 ..With means to increase breakdown voltage (e.g., field shield electrode, guard ring, etc.)
410 ..Gate insulator includes material (including air or vacuum) other than SiO2
411 ...Composite or layered gate insulator (e.g., mixture such as silicon oxynitride)
412 ..Gate electrode of refractory material (e.g., polysilicon or silicide of a refractory or platinum group metal)
413 ...Polysilicon laminated with silicide
414 **RESPONSIVE TO NON-ELECTRICAL SIGNAL (E.G., CHEMICAL, STRESS, LIGHT, OR MAGNETIC FIELD SENSORS)**
415 .(E) Physical deformation
416 ..Acoustic wave
417 ..Strain sensors
418 ...With means to concentrate stress
419 ....With thinned central active portion of semiconductor surrounded by thick insensitive portion (e.g., diaphragm type strain gauge)
420 ..Means to reduce sensitivity to physical deformation
421 .(E) Magnetic field
422 ..With magnetic field directing means (e.g., shield, pole piece, etc.)
423 ..Bipolar transistor magnetic field sensor (e.g., lateral bipolar transistor)
424 ..Sensor with region of high carrier recombination (e.g., magnetodiode with carriers deflected to recombination region by magnetic field)
425 ..Magnetic field detector using compound semiconductor material (e.g., GaAs, InSb, etc.)
426 ..Differential output (e.g., with offset ajustment means or with means to reduce temperature sensitivity)
427 ..(E) Magnetic field sensor in integrated circuit (e.g., in bipolar transistor integrated circuit)
428 .(E) Electromagnetic or particle radiation
429 ..(E) Charged or elementary particles
430 ...(E) With active region having effective impurity concentration less than 1012 atoms/cm3
431 ..(E) Light
432 ...(E) With optical element
433 ...(E) With housing or encapsulation
434 ....(E) With window means
435 ...(E) With optical shield or mask means
436 ...(E) With means for increasing light absorption (e.g., redirection of unabsorbed light)
437 ....(E) Antireflection coating
438 ...(E) Avalanche junction
439 ...(E) Containing dopant adapted for photoionization
440 ...(E) With different sensor portions responsive to different wavelengths (e.g., color imager)
441 ...(E) Narrow band gap semiconductor () (e.g., PbSnTe)
442 ....(E) II-VI compound semiconductor (e.g., HgCdTe)
443 ...(E) Matrix or array (e.g., single line arrays)

444 ....(E) Light sensor elements overlie active switching elements in integrated circuit (e.g., where the sensor elements are deposited on an integrated circuit)
445 ....(E) With antiblooming means
446 ....(E) With specific isolation means in intgrated circuit
447 ....(E) With backside illumination (e.g., having a thinned central area or a non-absorbing substrate)
448 ....(E) With particular electrode configuration
449 ...(E) Schottky barrier (e.g., a transparent Schottky metallic layer or a Schottky barrier containing at least one of indium or tin (e.g., SnO2, indium tin oxide))
450 ....(E) With doping profile to adjust barrier height
451 ....(E) Responsive to light having lower energy (i.e., longer wavelength) than forbidden band gap energy of semiconductor (e.g., by excitation of carriers from metal into semiconductor)
452 ....(E) With edge protection, e.g., doped guard ring or mesa structure
453 ....(E) With specified Schottky metallic layer
454 .....(E) Schottky metallic layer is a silicide
455 ......(E) Silicide of Platinum group metal
456 ......(E) Silicide of refractory metal
457 ....(E) With particular contact geometry (e.g., ring or grid)
458 ...(E) PIN detector, including combinations with non-light responsive active devices
459 ...(E) With particular contact geometry (e.g., ring or grid, or bonding pad arrangement)
460 ...(E) With backside illumination (e.g., with a thinned central area or non-absorbing substrate)
461 ...(E) Light responsive pn junction
462 ....(E) Phototransistor
463 ....(E) With particular doping concentration
464 ....(E) With particular layer thickness (e.g., layer less than light absorption depth)
465 ....(E) Geometric configuration of junction (e.g., fingers)
466 ...(E) External physical configuration of semiconductor (e.g., mesas, grooves)
467 .Temperature
468 ..Semiconductor device operated at cryogenic temperature
469 ..With means to reduce temperature sensitivity (e.g., reduction of temperature sensitivity of junction breakdown voltage by using a compensating element)
470 ..Pn junction adapted as temperature sensor
471 **(E) SCHOTTKY BARRIER**
472 .(E) To compound semiconductor
473 ..With specified Schottky metal
474 .As active junction in bipolar transistor (e.g., Schottky collector)
475 .With doping profile to adjust barrier height
476 .(E) In integrated structure
477 ..(E) With bipolar transistor
478 ...(E) Plural Schottky barriers with different barrier heights
479 ...(E) Connected across base-collector junction of transistor (e.g., Baker clamp)
480 .In voltage variable capacitance diode
481 .(E) Avalanche diode (e.g., so-called "Zener" diode having breakdown voltage greater than 6 volts)
482 ..(E) Microwave transit time device (e.g., IMPATT diode)
483 .With means to prevent edge breakdown
484 ..(E) Guard ring
485 .Specified materials
486 ..Layered (e.g., a diffusion barrier material layer or a silicide layer or a precious metal layer)
487 **(E) WITH MEANS TO INCREASE BREAKDOWN VOLTAGE THRESHOLD**
488 .(E) Field relief electrode

489 ..Resistive
490 ..Combined with floating pn junction guard region
491 .(E) In integrated circuit
492 ..(E) With electric field controlling semiconductor layer having a low enough doping level in relationship to its thickness to be fully depleted prior to avalanche breakdown (e.g., RESURF devices)
493 .With electric field controlling semiconductor layer having a low enough doping level in relationship to its thickness to be fully depleted prior to avalanche breakdown (e.g., RESURF devices)
494 .Reverse-biased pn junction guard region
495 .Floating pn junction guard region
496 .With physical configuration of semiconductor surface to reduce electric field (e.g., reverse bevels, double bevels, stepped mesas, etc.)
497 **(E) PUNCHTHROUGH STRUCTURE DEVICE (E.G., PUNCHTHROUGH TRANSISTOR, CAMEL BARRIER DIODE)**
498 .(E) Punchthrough region fully depleted at zero external applied bias voltage (e.g., camel barrier or planar doped barrier devices, or so-called "bipolar SIT" devices)
499 **(E) INTEGRATED CIRCUIT STRUCTURE WITH ELECTRICALLY ISOLATED COMPONENTS**
500 .(E) Including high voltage or high power devices isolated from low voltage or low power devices in the same integrated circuit
501 ..(E) Including dielectric isolation means
502 ..(E) High power or high voltage device extends completely through semiconductor substrate (e.g., backside collector contact)
503 .(E) With contact or metallization configuration to reduce parasitic coupling (e.g., separate ground pads for different parts of integrated circuit)
504 .(E) Including means for establishing a depletion region throughout a semi-conductor layer for isolating devices in different portions of the layer (e.g., "JFET" isolation)
505 .(E) With polycrystalline semiconductor isolation region in direct contact with single crystal active semiconductor material
506 .(E) Including dielectric isolation means
507 ..(E) With single crystal insulating substrate (e.g., sapphire)
508 ..(E) With metallic conductor within isolating dielectric or between semiconductor and isolating dielectric (e.g., metal shield layer or internal connection layer)
509 ..(E) Combined with pn junction isolation (e.g., isoplanar, LOCOS)
510 ...(E) Dielectric in groove
511 ....(E) With complementary (npn and pnp) bipolar transistor structures)
512 .....(E) Complementary devices share common active region (e.g., integrated injection logic, I2L)
513 ....(E) Vertical walled groove
514 .....(E) With active junction abutting groove (e.g., "walled emitter")
515 ....(E) With active junction abutting groove (e.g., "walled emitter")
516 ....(E) With passive component (e.g., resistor, capacitor, etc.)
517 ....(E) With bipolar transistor structure
518 .....(E) With polycrystalline connecting region (e.g., polysilicon base contact)

519 ....(E) Including heavily doped channel stop region adjacent groove
520 ....(E) Conductive filling in dielectric-lined groove (e.g., polysilicon backfill)
521 ....(E) Sides of grooves along major crystal planes (e.g., (111), (100) planes, etc.)
522 ..(E) Air isolation (e.g., beam lead supported semiconductor islands)
523 ..(E) Isolation by region of intrinsic (undoped) semiconductor material (e.g., including region physically damaged by proton bombardment)
524 ..(E) Full dielectric isolation with polycrystalline semiconductor substrate
525 ...(E) With complementary (npn and pnp) bipolar transistor structures
526 ..(E) With bipolar transistor structure
527 ...(E) Sides of isolated semiconductor islands along major crystal planes (e.g., (111), (100) planes, etc.)
528 .(E) Passive components in ICs
529 ..(E) Including programmable passive component (e.g., fuse)
530 ...(E) Anti-fuse
531 ..(E) Including inductive element
532 ..(E) Including capacitor component
533 ...(E) Combined with resistor to form RC filter structure
534 ...(E) With means to increase surface area (e.g., grooves, ridges, etc.)
535 ...(E) Both terminals of capacitor isolated from substrate
536 ..(E) Including resistive element
537 ...(E) Using specific resistive material
538 ....(E) Polycrystalline silicon (doped or undoped)
539 ...(E) Combined with bipolar transistor
540 ....(E) With compensation for non-linearity (e.g., dynamic isolation pocket bias)
541 ....(E) Pinch resistor
542 ....(E) Resistor has same doping as emitter or collector of bipolar transistor
543 ....(E) Lightly doped junction isolated resistor (e.g., ion implanted resistor)
544 .(E) With pn junction isolation
545 ..(E) With means to control isolation junction capacitance (e.g., lightly doped layer at isolation junction to increase depletion layer width)
546 ..(E) With structural means to protect against excess or reversed polarity voltage
547 ..(E) With structural means to control parasitic transistor action or leakage current
548 ..(E) At least three regions of alternating conductivity types with dopant concentration gradients decreasing from surface of semiconductor (e.g., "triple-diffused" integrated circuit)
549 ..(E) With substrate and lightly doped surface layer of same conductivity type, separated by subsurface heavily doped region of opposite conductivity type (e.g., "collector diffused isolation" integrated circuit)
550 ..(E) With lightly doped surface layer of one conductivity type on substrate of opposite conductivity type, having plural heavily doped portions of the one conductivity type between the layer and substrate, different ones of the heavily doped portions having differing depths or physical extent
551 ..(E) Including voltage reference element (e.g., avalanche diode, so-called "Zener diode" with breakdown voltage greater than 6 volts or with positive temperature coefficient of breakdown voltage)
552 ..(E) With bipolar transistor structure

553 ...(E) Transistors of same conductivity type (e.g., npn) having different current gain or different operating voltage characteristics
554 ...(E) With connecting region made of polycrystalline semiconductor material (e.g., polysilicon base contact)
555 ...(E) Complementary bipolar transistor structures (e.g., integrated injection logic, I2L)
556 ....(E) Including lateral bipolar transistor structure
557 .(E) Lateral bipolar transistor structure
558 ..(E) With base region doping concentration step or gradient or with means to increase current gain
559 ..(E) With active region formed along groove or exposed edge in semiconductor
560 ..(E) With multiple collectors or emitters
561 ...(E) With different emitter to collector spacings or facing areas
562 ...(E) With auxiliary collector/re-emitter between emitter and output collector (e.g., "current hogging logic" device)
563 .(E) With multiple separately connected emitter, collector, or base regions in same transistor structure
564 ..(E) Multipe base or collector regions
565 **(E) BIPOLAR TRANSISTOR STRUCTURE**
566 .(E) Plural non-isolated transistor structures in same structure
567 ..(E) Darlington configuration (i.e., emitter to collector current of input transistor supplied to base region of output transistor)
568 ...(E) More than two Darlington-connected transistors
569 ...(E) Complementary Darlington-connected transistors
570 ...(E) With active components in addition to Darlington transistors (e.g., antisaturation diode, bleeder diode connected antiparallel to input transistor base-emitter junction, etc.)
571 ...(E) Non-planar structure (e.g., mesa emitter, or having a groove to define resistor)
572 ...(E) With resistance means connected between transistor base regions
573 ...(E) With housing or contact structure or configuration
574 ..(E) Complementary transistors share common active region (e.g., integrated injection logic I2L)
575 ...(E) Including lateral bipolar transistor structure
576 ....(E) With contacts of refractory material (e.g., polysilicon, silicide of refractory or platinum group metal)
577 .(E) Including additional component in same, non-isolated structure (e.g., transistor with diode, transistor with resistor, etc.)
578 .(E) With enlarged emitter area (e.g., power device)
579 ..(E) With separate emitter areas connected in parallel
580 ...(E) With current ballasting means (e.g., emitter ballasting resistors or base current ballasting means)
581 ....(E) Thin film ballasting means (e.g., polysilicon resistor)
582 ..(E) With current ballasting means (e.g., emitter ballasting resistors or base current ballasting resistors)
583 ..With means to reduce transistor action in selected portions of transistor (e.g., heavy base region doping under central web of emitter to prevent secondary breakdown)
584 ..With housing or contact (i.e., electrode) means

585 .With means to increase inverse gain
586 .(E) With non-planar semiconductor surface (e.g., groove, mesa, bevel, etc.)
587 .With specified electrode means
588 ..Including polycrystalline semiconductor as connection
589 .(E) Avalanche transistor
590 .With means to reduce minority carrier lifetime (e.g., region of deep level dopant or region of crystal damage)
591 .With emitter region having specified doping concentration profile (e.g., high-low concentration step)
592 .(E) With base region having specified doping concentration profile or specified configuration (e.g., inactive base more heavily doped than active base or base region has constant doping concentration portion (e.g., epitaxial base))
593 .With means to increase current gain or operating frequency
594 **(E) WITH GROOVE TO DEFINE PLURAL DIODES**
595 **(E) VOLTAGE VARIABLE CAPACITANCE DEVICE**
596 .With specified dopant profile
597 ..Retrograde dopant profile (e.g., dopant concentration decreases with distance from rectifying junction)
598 .With plural junctions whose depletion regions merge to vary voltage dependence
599 .With means to increase active junction area (e.g., grooved or convoluted surface)
600 .With physical configuration to vary voltage dependence (e.g., mesa)
601 .(E) Plural diodes in same non-isolated structure, or device having three or more terminals
602 .With specified housing or contact
603 **(E) AVALANCHE DIODE (E.G., SO-CALLED "ZENER" DIODE HAVING BREAKDOWN VOLTAGE GREATER THAN 6 VOLTS)**
604 .(E) Microwave transit time device (e.g., IMPATT diode)
605 .(E) With means to limit area of breakdown (e.g., guard ring having higher breakdown voltage)
606 ..Subsurface breakdown
607 **WITH SPECIFIED DOPANT (E.G., PLURAL DOPANTS OF SAME CONDUCTIVITY IN SAME REGION)**
608 .Switching device based on filling and emptying of deep energy levels
609 .For compound semiconductor (e.g., deep level dopant)
610 .Deep level dopant
611 ..With specified distribution (e.g., laterally localized, with specified concentration distribution or gradient)
612 ..Deep level dopant other than gold or platinum
613 **(E) INCLUDING SEMICONDUCTOR MATERIAL OTHER THAN SILICON OR GALLIUM ARSENIDE (GAAS) (E.G., PBXSN1-XTE)**
614 .(E) Group II-VI compound (e.g., CdTe, HgxCd1-xTe)
615 .(E) Group III-V compound (e.g., InP)
616 .(E) Containing germanium, Ge
617 **(E) INCLUDING REGION CONTAINING CRYSTAL DAMAGE**
618 **(E) PHYSICAL CONFIGURATION OF SEMICONDUCTOR (E.G., MESA, BEVEL, GROOVE, ETC.)**
619 .With thin active central semiconductor portion surrounded by thicker inactive shoulder (e.g., for mechanical support)
620 .With peripheral feature due to separation of smaller semiconductor chip from larger wafer (e.g., scribe region, or means to prevent edge effects such as leakage current at peripheral chip separation area)
621 .With electrical contact in hole in semiconductor (e.g., lead extends through semiconductor body)
622 .Groove

623 .(E) Mesa structure (e.g., including undercut or stepped mesa configuration or having constant slope taper)
624 ..With low resistance ohmic connection means along exposed mesa edge (e.g., contact or heavily doped region along exposed mesa to reduce "skin effect" losses in microwave diode)
625 ..Semiconductor body including mesa is intimately bonded to thick electrical and/or thermal conductor member of larger lateral extent than semiconductor body (e.g., "plated heat sink" microwave diode)
626 ..Combined with passivating coating
627 .(E) With specified crystal plane or axis
628 ..Major crystal plane or axis other than (100), (110), or (111) (e.g., (731) axis, crystal plane several degrees from (100) toward (011), etc.)
629 **(E) WITH MEANS TO CONTROL SURFACE EFFECTS**
630 .(E) With inversion-preventing shield electrode
631 .In compound semiconductor material (e.g., GaAs)
632 .(E) Insulating coating
633 ..With thermal expansion compensation (e.g., thermal expansion of glass passivant matched to that of semiconductor)
634 ..Insulating coating of glass composition containing component to adjust melting or softening temperature (e.g., low melting point glass)
635 ..Multiple layers
636 ...At least one layer of semi-insulating material
637 ...Three or more insulating layers
638 ...With discontinuous or varying thickness layer (e.g., layer covers only selected portions of semiconductor)
639 ...At least one layer of silicon oxynitride
640 ...At least one layer of silicon nitride
641 ....Combined with glass layer
642 ...(E) At least one layer of organic material
643 ....(E) Polyimide or polyamide
644 ...At least one layer of glass
645 ...Insulating layer containing specified electrical charge (e.g., net negative electrical charge)
646 ..Coating of semi-insulating material (e.g., amorphous silicon or silicon-rich silicon oxide)
647 ..Insulating layer recessed into semiconductor surface (e.g., LOCOS oxide)
648 ...Combined with channel stop region in semiconductor
649 ..Insulating layer of silicon nitride or silicon oxynitride
650 ..Insulating layer of glass
651 ..Details of insulating layer electrical charge (e.g., negative insulator layer charge)
652 .(E) Channel stop layer
653 **(E) WITH SPECIFIED SHAPE OF PN JUNCTION**
654 .Interdigitated pn junction or more heavily doped side of junction is concave
655 **WITH SPECIFIED IMPURITY CONCENTRATION GRADIENT**
656 .With high resistivity (e.g., "intrinsic") layer between p and n layers (e.g., PIN diode)
657 .Stepped profile
658 **PLATE TYPE RECTIFIER ARRAY**
659 **(E) WITH SHIELDING (E.G., ELECTRICAL OR MAGNETIC SHIELDING, OR FROM ELECTROMAGNETIC RADIATION OR CHARGE PARTICLES)**
660 .(E) With means to shield device contained in housing or package from charged particles (e.g., alpha particles) or highly ionizing radiation (i.e., hard X-rays or shorter wavelength)
661 **(E) SUPERCONDUCTIVE CONTACT OR LEAD**
662 .Transmission line or shielded

663 .On integrated circuit
664 **TRANSMISSION LINE LEAD (E.G., STRIPLINE, COAX, ETC.)**
665 **CONTACTS OR LEADS INCLUDING FUSIBLE LINK MEANS OR NOISE SUPPRESSION MEANS**
666 **LEAD FRAME**
667 .With dam or vent for encapsulant
668 .On insulating carrier other than a printed circuit board
669 .With stress relief
670 .With separate tie bar element or plural tie bars
671 ..Of insulating material
672 .Small lead frame (e.g., "spider" frame) for connecting a large lead frame to a semiconductor chip
673 .With bumps on ends of lead fingers to connect to semiconductor
674 .With means for controlling lead tension
675 .With heat sink means
676 .With structure for mounting semiconductor chip to lead frame (e.g., configuration of die bonding flag, absence of a die bonding flag, recess for LED)
677 .Of specified material other than copper (e.g., Kovar (T.M.))
678 **HOUSING OR PACKAGE**
679 .Smart (e.g., credit) card package
680 .(E) With window means
681 ..(E) For erasing EPROM
682 .With desiccant, getter, or gas filling
683 .With means to prevent explosion of package
684 .With semiconductor element forming part (e.g., base, of housing)
685 .(E) Multiple housings
686 ..(E) Stacked arrangement
687 .Housing or package filled with solid or liquid electrically insulating material
688 .With large area flexible electrodes in press contact with opposite sides of active semiconductor chip and surrounded by an insulating element (e.g., ring)
689 ..Rigid electrode portion
690 .With contact or lead
691 ..Having power distribution means (e.g., bus structure)
692 ..With particular lead geometry
693 ...External connection to housing
694 ....Axial leads
695 ....Fanned/radial leads
696 ....Bent (e.g., J-shaped) lead
697 ....Pin grid type
698 ..With specific electrical feedthrough structure
699 ...Housing entirely of metal except for feedthrough structure
700 ..Multiple contact layers separated from each other by insulator means and forming part of a package of housing (e.g., plural ceramic layer package)
701 .Insulating material
702 ..Of insulating material other than ceramic
703 ..Composite ceramic, or single ceramic with metal
704 ..Cap or lid
705 ..Of high thermal conductivity ceramic (e.g., BeO)
706 ..With heat sink
707 ...Directly attached to semiconductor device
708 .Entirely of metal except for feedthrough
709 ..With specified insulator to isolate device from housing
710 ..With specified means (e.g., lip) to seal base to cap
711 ..With raised portion of base for mounting semiconductor chip
712 .With provision for cooling the housing or its contents
713 ..For integrated circuit
714 ..Liquid coolant
715 ...Boiling (evaporative) liquid
716 ...Cryogenic liquid coolant
717 ..Isolation of cooling means (e.g., heat sink) by an electrically insulating element (e.g., spacer)
718 ..Heat dissipating element held in place by clamping or spring means
719 ...Pressed against semiconductor element

720 ..Heat dissipating element has high thermal conductivity insert (e.g., copper slug in aluminum heat sink)
721 ..With gas coolant
722 ...With fins
723 .(E) For plural devices
724 ..(E) With discrete components
725 ..(E) With electrical isolation means
726 ...(E) Devices held in place by clamping
727 .Device held in place by clamping
728 .For high frequency (e.g., microwave) device
729 .Portion of housing of specific materials
730 .Outside periphery of package having specified shape or configuration
731 .With housing mount
732 ..Flanged mount
733 ..Stud mount
734 **(E) COMBINED WITH ELECTRICAL CONTACT OR LEAD**
735 .Beam leads (i.e., leads that extend beyond the ends or sides of a chip component)
736 ..Layered
737 .Bump leads
738 ..Ball shaped
739 .With textured surface
740 .With means to prevent contact from penetrating shallow pn junction (e.g., prevention of aluminum "spiking")
741 .(E) Of specified material other than unalloyed aluminum
742 ..With a semiconductor conductivity substitution type dopant (e.g., germanium in the case of a gallium arsenide semiconductor) in a contact metal
743 ...For compound semiconductor contact material
744 ..(E) For compound semiconductor material
745 ...(E) Contact for III-V material
746 ..Composite material (e.g., fibers or strands embedded in solid matrix)
747 ..With thermal expansion matching of contact or lead material to semiconductor active device
748 ...Plural layers of specified contact or lead material
749 ..(E) At least portion of which is transparent to ultraviolet, visible or infrared light
750 ..(E) Layered
751 ...(E) At least one layer forms a diffusion barrier
752 ...Planarized to top of insulating layer
753 ...With adhesion promoting means (e.g., layer of material) to promote adhesion of contact to an insulating layer
754 ...(E) At least one layer of silicide or polycrystalline silicon
755 ....Polysilicon laminated with silicide
756 ....Multiple polysilicon layers
757 ....Silicide of refractory or platinum group metal
758 ...Multiple metal levels on semiconductor, separated by insulating layer (e.g., multiple level metallization for integrated circuit)
759 ....(E) Including organic insulating material between metal levels
760 ....Separating insulating layer is laminate or composite of plural insulating materials (e.g., silicon oxide on silicon nitride, silicon oxynitride)
761 ...At least one layer containing vanadium, hafnium, niobium, zirconium, or tantalum
762 ...At least one layer containing silver or copper
763 ...At least one layer of molybdenum, titanium, or tungsten
764 ....Alloy containing molybdenum, titanium, or tungsten
765 ...At least one layer of an alloy containing aluminum
766 ...At least one layer containing chromium or nickel
767 ..Resistive to electromigration or diffusion of the contact or lead material

768 ..Refractory or platinum group metal or alloy or silicide thereof
769 ...Platinum group metal or silicide thereof
770 ...Molybdenum, tungsten, or titanium or their silicides
771 ..Alloy containing aluminum
772 ..Solder composition
773 .(E) Of specified configuration
774 ..Via (interconnection hole) shape
775 ..Varying width or thickness of conductor
776 ..Cross-over arrangement, component or structure
777 .Chip mounted on chip
778 .Flip chip
779 .Solder wettable contact, lead or bond
780 .Ball or nail head type contact, lead or bond
781 ..Layered contact, lead or bond
782 .Die bond
783 ..With adhesive means
784 .Wire contact, lead or bond
785 .By pressure alone
786 .Configuration or pattern of bonds
787 **ENCAPSULATED**
788 .With specified encapsulant
789 ..With specified filler material
790 ..Plural encapsulating layers
791 ..Including polysiloxane (e.g., silicone resin)
792 ..(E) Including polyimide
793 ..(E) Including epoxide
794 ..Including glass
795 .With specified filler material
796 .With heat sink embedded in encapsulant
797 **ALIGNMENT MARKS**
798 **MISCELLANEOUS**

E-SUBCLASSES

The following subclasses beginning with the letter E are E-subclasses. Each E-subclass corresponds to a classification in the European Classification system (ECLA). The ECLA classification is parenthesized at the end of the title. E-subclasses contain both U.S. and foreign documents. New U.S. documents are classified here by the USPTO, and European foreign by the EPO. E-subclasses may contain subject matter outside the scope of this class. Consult their definitions, or the documents themselves to clarify or interpret titles.

E29.001 **DETAILS OF SEMICONDUCTOR BODIES OR ELECTRODES OF SEMICONDUCTOR DEVICES ADAPTED FOR RECTIFYING, AMPLIFYING, OSCILLATING OR SWITCHING, OR CAPACITORS OR RESISTORS WITH AT LEAST ONE POTENTIAL-JUMP BARRIER OR SURFACE BARRIER (E.G., PN JUNCTION DEPLETION LAYER OR CARRIER CONCENTRATION LAYER) (EPO)**
E29.002 .Electrical characteristics due to properties of entire semiconductor body rather than just surface region (EPO)
E29.003 ..Characterized by their crystalline structure (e.g., polycrystalline, cubic) particular orientation of crystalline planes (EPO)
E29.004 ...With specified crystalline planes or axis (EPO)
E29.005 ..Characterized by specified shape or size of PN junction or by specified impurity concentration gradient within device (EPO)
E29.006 ...Characterized by particular design considerations to control electrical field effect within device (EPO)
E29.007 ....For controlling surface leakage or electric field concentration (EPO)
E29.008 .....For controlling breakdown voltage of reverse biased devices (EPO)
E29.009 ......With field relief electrode (field plate) (EPO)
E29.01 ....With at least two field relief electrodes used in combination and not electrically interconnected (EPO)

E29.011 ....With one or more field relief electrode comprising resistance material (e.g., semi insulating material, lightly doped poly-sillcon) poly-silicon) (EPO)
E29.012 ......By doping profile or shape or arrangement of PN junction, or with supplementary regions (e.g., guard ring, LDD, drift region) (EPO)
E29.013 ....With supplementary region doped oppositely to or in rectifying contact with semiconductor containing or contacting region (e.g., guard rings with PN or Schottky junction) (EPO)
E29.014 ....With breakdown supporting region for localizing breakdown or limiting its voltage I82 (EPO)
E29.015 ......With insulating layer characterized by dielectric or electrostatic property (e.g., including fixed charge or semi-insulating surface layer) (EPO)
E29.016 .....For preventing surface leakage due to surface inversion layer (e.g., channel stop) (EPO)
E29.017 ......With field relief electrodes acting on insulator potential or insulator charges (EPO)
E29.018 ....Comprising internal isolation within devices or components (EPO)
E29.019 .....Isolation by PN junctions (EPO)
E29.02 .....Isolation by dielectric regions (EPO)
E29.021 ......For source or drain region of field effect device (EPO)
E29.022 ...Characterized by shape of semiconductor body (EPO)
E29.023 ....Adapted for altering junction breakdown voltage by shape of semiconductor body (EPO)
E29.024 ...Characterized by shape, relative sizes or dispositions of semiconductor regions or junctions between regions (EPO)
E29.025 ....Characterized by particular shape of junction between semiconductor regions (EPO)
E29.026 ....Surface layout of the device (EPO)
E29.027 .....Surface layout of MOS gated device (e.g., DMOSFET or IGBT) (EPO)
E29.028 ......With nonplanar gate structure (EPO)
E29.029 ...With semiconductor regions connected to electrode carrying current to be rectified, amplified, or switched and such electrode being part of semiconductor device which comprises three or more electrodes (EPO)
E29.03 ....Emitter regions of bipolar transistors (EPO)
E29.031 .....Of lateral transistors (EPO)
E29.032 .....Noninterconnected multiemitter structures (EPO)
E29.033 .....Of heterojunction bipolar transistors (EPO)
E29.034 ....Collector regions of bipolar transistors (EPO)
E29.035 .....Pedestal collectors (EPO)
E29.036 ....Anode or cathode regions of thyristors or gated bipolar-mode devices (EPO)
E29.037 .....Anode regions of thyristors or gated bipolar-mode devices (EPO)
E29.038 .....Cathode regions of thyristors (EPO)
E29.039 ....Source or drain regions of field-effect devices (EPO)
E29.04 .....Of field-effect transistors with insulated gate (EPO)
E29.041 .....Of field-effect transistors with Schottky gate (EPO)
E29.042 ....Tunneling barrier (EPO)
E29.043 ...With semiconductor regions connected to electrode not carrying current to be rectified, amplified, or switched and such electrode being part of semiconductor device which comprises three or more electrodes (EPO)
E29.044 ....Base region of bipolar transistors (EPO)
E29.045 .....Of lateral transistors (EPO)

E29.046 ....Base regions of thyristors (EPO)
E29.047 .....Anode base regions of thyristors (EPO)
E29.048 .....Cathode base regions of thyristors (EPO)
E29.049 ....Channel region of field-effect devices (EPO)
E29.05 .....Of field-effect transistors (EPO)
E29.051 ......With insulated gate (EPO)
E29.052 ....Nonplanar channel (EPO)
E29.053 ....With nonuniform doping structure in channel region surface (EPO)
E29.054 ....Doping structure being parallel to channel length (EPO)
E29.055 ....With vertical doping variation (EPO)
E29.056 ....With variation of composition of channel (EPO)
E29.057 ......With PN junction gate (EPO)
E29.058 .....Of charge coupled devices (EPO)
E29.059 ....Gate region of field-effect devices with PN junction gate (EPO)
E29.06 ....Substrate region of field-effect devices (EPO)
E29.061 .....Of field-effect transistors (EPO)
E29.062 ......With insulated gate (EPO)
E29.063 ....With inactive supplementary region (e.g., for preventing punch-through, improving capacity effect or leakage current) (EPO)
E29.064 ....Characterized by contact structure of substrate region (EPO)
E29.065 .....Of charge coupled devices (EPO)
E29.066 ....Body region structure IGFET's with channel containing layer (DMOSFET or IGBT) (EPO)
E29.067 .....With nonplanar gate structure (EPO)
E29.068 ..Characterized by materials of semiconductor body (EPO)
E29.069 ...Single quantum well structures (EPO)
E29.07 ....Quantum wire structures (EPO)
E29.071 ....Quantum box or quantum dot structures (EPO)
E29.072 ...Structures with periodic or quasi periodic potential variation (e.g., multiple quantum wells, superlattices) (EPO)
E29.073 ....Doping structures (e.g., doping superlattices, nipi-superlattices) (delta doping, in general) (EPO)
E29.074 ....Structures without potential periodicity in direction perpendicular to major surface of substrate (e.g., lateral superlattice) (EPO)
E29.075 ....Compositional structures (EPO)
E29.076 .....With layered structures with quantum effects in vertical direction (EPO)
E29.077 ......Compromising at least one long-range structually disordered material (e.g., one-dimensional vertical amorphous superlattices) (EPO)
E29.078 ......Comprising only semiconductor materials (EPO)
E29.079 ...Two or more elements from two or more groups of Periodic Table of elements (e.g., alloys) (EPO)
E29.08 ....Amorphous materials (EPO)
E29.081 ....In different semiconductor regions (e.g., heterojunctions) (EPO)
E29.082 ...Only element from fourth group of Periodic System in uncombined form (EPO)
E29.083 ....Amorphous materials (EPO)
E29.084 ....Including two or more of elements from fourth group of Periodic System (EPO)
E29.085 .....In different semiconductor regions (e.g., heterojunctions) (EPO)
E29.086 ....Further characterized by doping material (EPO)
E29.087 ...Selenium or tellurium only (EPO)
E29.088 ....Amorphous materials (EPO)
E29.089 ...Only Group III-V compounds (EPO)
E29.09 ....Including two or more compounds (e.g. alloys) (EPO)

E29.091 .....In different semiconductor regions (e.g., heterojunctions) heterojunctions (EPO)
E29.092 ....Amorphous materials (EPO)
E29.093 ....Further characterized by doping material (EPO)
E29.094 ...Only GROUP II-VI compounds (EPO)
E29.095 ....Amorphous materials (EPO)
E29.096 ....Including two or more compounds (e.g. alloys) (EPO)
E29.097 .....In different semiconductor regions (e.g., heterojunctions) (EPO)
E29.098 ....Further characterized by doping material (EPO)
E29.099 ....Cd X compounds being one element of the sixth group of Periodic System (EPO)
E29.1 ...Semiconductor materials other than Group IV, selenium, tellurium, or Group III-V compounds (EPO)
E29.101 ....Amorphous materials (EPO)
E29.102 ....Group I-VI or I-VII compounds (e.g., Cu2O, CuI) (EPO)
E29.103 ....Pb compounds (e.g., PbO) (EPO)
E29.104 ....Si compounds (e.g., SiC) (EPO)
E29.105 ..Characterized by combinations of two or more features of crystalline structure, shape, materials, physical imperfections, and concentration/distribution of impurities in bulk material (EPO)
E29.106 ..Characterized by physical imperfections; having polished or roughened surface (EPO)
E29.107 ...Imperfections within semiconductor body (EPO)
E29.108 ...Imperfections on surface of semiconductor body (EPO)
E29.109 ..Characterized by concentration or distribution of impurities in bulk material (EPO)
E29.11 ...Planar doping (e.g., atomic-plane doping, delta-doping) (EPO)
E29.111 .Electrodes (EPO)
E29.112 ..Characterized by their shape, relative sizes, or dispositions (EPO)
E29.113 ...Carrying current to be rectified, amplified, or switched (EPO)
E29.114 ....Emitter or collector electrodes for bipolar transistors (EPO)
E29.115 ....Cathode or anode electrodes for thyristors (EPO)
E29.116 ....Source or drain electrodes for field effect devices (EPO)
E29.117 .....For thin film transistors with insulated gate (EPO)
E29.118 .....For vertical current flow (EPO)
E29.119 .....For lateral devices where connection to source or drain region is done through at least one part of semiconductor substrate thickness (e.g., with connecting sink or with via-hole) (EPO)
E29.12 .....Layout configuration for lateral device source or drain region (e.g., cellular, interdigitated or ring structure or being curved or angular) (EPO)
E29.121 .....Source or drain electrode in groove (EPO)
E29.122 .....Characterized by relative position of source or drain electrode and gate electrode (EPO)
E29.123 ...Not carrying current to be rectified, amplified, or switched (EPO)
E29.124 ....Base electrodes for bipolar transistors (EPO)
E29.125 ....Gate electrodes for thyristors (EPO)
E29.126 ....Gate stack for field effect devices (EPO)
E29.127 .....For field-effect transistors (EPO)
E29.128 ......With insulated gate (EPO)
E29.129 ....Gate electrodes for transistors with floating gate (EPO)
E29.13 ....Gate electrodes for nonplanar MOSFET (EPO)

E29.131 .....Having drain and source regions at different vertical level having channel composed only of vertical sidewall connecting drain and source layers (EPO)
E29.132 .....Characterized by insulating layer (EPO)
E29.133 .....Nonuniform insulating layer thickness (EPO)
E29.134 .....Characterized by configuration of gate electrode layer (EPO)
E29.135 .....Characterized by length or sectional shape (EPO)
E29.136 .....Characterized by surface lay-out (EPO)
E29.137 .....Characterized by configuration of gate stack of thin film FETs (EPO)
E29.138 .....For charge coupled devices (EPO)
E29.139 ..Of specified material (EPO)
E29.14 ...For gate of heterojunction field effect devices (EPO)
E29.141 ...Resistive materials for field effect devices (EPO)
E29.142 ...Superconductor materials (EPO)
E29.143 ...Ohmic electrodes (EPO)
E29.144 ....On Group III-V material (EPO)
E29.145 .....On thin film Group III-V material (EPO)
E29.146 ....On silicon (EPO)
E29.147 .....For thin film silicon (EPO)
E29.148 ...Schottky barrier electrodes (EPO)
E29.149 ....On Group III-V material (EPO)
E29.15 ...Electrodes for IGFET (EPO)
E29.151 ....For TFT (EPO)
E29.152 ....With lateral structure (e.g., Poly-silicon gate with lateral doping variation or with lateral composition variation or characterized by sidewalls being composed of conductive, resistivity) (EPO)
E29.154 ....Silicon gate conductor material (EPO)
E29.155 .....Multiple silicon layers (EPO)
E29.156 ......Including silicide layer contacting silicon layer (EPO)
E29.157 ......Including barrier layer between silicon and non-Si electrode (EPO)
E29.158 ....Elemental metal gate conductor material (e.g. W, Mo) (EPO)
E29.159 .....Diverse conductors (EPO)
E29.16 ....Gate conductor material being compound or alloy material (e.g., organic material, TiN, MoSi2) (EPO)
E29.161 .....Silicide (EPO)
E29.162 ....Insulating materials for IGFET (EPO)
E29.164 .....With at least one ferroelectric layer (EPO)
E29.165 .....Multiple layers (EPO)
E29.166 .Types of semiconductor semiconductor device (EPO)
E29.167 ..Controllable by plural effects that include variations in magnetic field, mechanical force, or electric current/ potential applied to device or one or more electrodes of device (EPO)
E29.168 ..Quantum effect device (EPO)
E29.169 ..Controllable by only signal applied to control electrode (e.g., base of bipolar transistor, gate of field effect transistor) (EPO)
E29.17 ...Memory effect devices (EPO)
E29.171 ...Bipolar device (EPO)
E29.172 ....Double base diode (EPO)
E29.173 ....Transistor-type device (i.e., able to continuously respond to applied control signal) (EPO)
E29.174 .....Bipolar junction transistor (EPO)
E29.175 ......Structurally associated with other devices (EPO)
E29.176 ......Device being resistive element (e.g., ballasting resistor) (EPO)
E29.177 ......Point contact transistors (EPO)
E29.178 ......Schottky transistors (EPO)
E29.179 ......Tunnel transistors (EPO)
E29.18 ......Avalanche transistors (EPO)
E29.181 ......Transistors with hook collectorie (i.e., collector having two layers of opposite conductivity type (e.g., SCR)) (EPO)
E29.182 ......Bipolar thin film transistors (EPO)

E29.183 ......Vertical transistor (EPO)
E29.184 ....Having emitter-base and base-collector junctions in same plane (EPO)
E29.185 ....Having emitter-base junction and base-collector junction on different surfaces (e.g., mesa planar transistor) (EPO)
E29.186 ....Inverse vertical transistor (EPO)
E29.187 ......Lateral transistor (EPO)
E29.188 ......Hetero-junction transistor (EPO)
E29.189 ....Vertical transistors (EPO)
E29.19 ....Having two-dimensional base (e.g., modulation-doped base, inversion layer base, delta-doped base) (EPO)
E29.191 ....Having an emitter comprising one or more non-monocrystalline elements of Group IV (e.g., amorphous silicon) alloys comprising Group IV elements (EPO)
E29.192 ....Resonant tunneling transistors (EPO)
E29.193 ....Comprising lattice mismatched active layers (e.g., SiGe strained layer transistors) (EPO)
E29.194 .....Controlled by field effect (e.g., bipolar static induction transistor (BSIT)) (EPO)
E29.195 ......Gated diode structure (EPO)
E29.196 ....With PN junction gate (e.g., field controlled thyristor (FCTh), static induction thyristor (SITh)) (EPO)
E29.197 ......Insulated gate bipolar mode transistor (e.g., IGBT, IGT, COMFET) (EPO)
E29.198 ....Transistor with vertical current flow (EPO)
E29.199 ....With both emitter and collector contacts in same substrate side (EPO)
E29.2 ....With nonplanar surface (e.g., with a nonplanar gate or with trench or recess or pillar in surface of emitter, base, or collector region for improving current density or short circuiting emitter and base regions) (EPO)
E29.201 ....And gate structure lying on slanted or vertical surface or formed in groove (e.g., trench gate IGBT) (EPO)
E29.202 ....Thin film device (EPO)
E29.211 ....Thyristor-type device (e.g., having four-zone regenerative action) (EPO)
E29.212 .....Gate-turn-off device (EPO)
E29.213 ......With turn off by field effect (EPO)
E29.214 ....Produced by insulated gate structure (EPO)
E29.215 .....Bidirectional device (e.g., triac) (EPO)
E29.216 .....With turn on by field effect (EPO)
E29.217 .....Combined structurally with at least one other device (EPO)
E29.218 ......Combined with capacitor or resistor (EPO)
E29.219 ......Combined with diode (EPO)
E29.22 ....Antiparallel diode (EPO)
E29.221 ......Combined with field effect transistor (EPO)
E29.222 .....Having built-in localized breakdown/breakover region (EPO)
E29.223 .....Having amplifying gate structure (e.g., Darlington configuration) (EPO)
E29.224 .....Asymmetrical thyristor (EPO)
E29.225 .....Lateral thyristor (EPO)
E29.226 ...Unipolar device (EPO)
E29.227 ....Charge transfer device (EPO)
E29.228 .....Charge-coupled device (EPO)
E29.229 ......With field effect produced by insulated gate (EPO)
E29.23 ....Input structure (EPO)
E29.231 ....Output structure (EPO)
E29.232 ....Structure for improving output signal (EPO)
E29.233 ....Buried channel CCD (EPO)
E29.234 ....Two-phase CCD (EPO)
E29.235 ....Three-phase CCD (EPO)
E29.236 ....Four-phase CCD (EPO)

E29.237 .....Surface channel CCD (EPO)
E29.238 .....Two-phase CCD (EPO)
E29.239 .....Three-phase CCD (EPO)
E29.24 .....Four-phase CCD (EPO)
E29.241 ....Hot electron transistor (HET) or metal base transistor (MBT) (EPO)
E29.242 ....Field effect transistor (EPO)
E29.243 .....Using static field induced region (e.g., SIT, PBT) (EPO)
E29.244 .....Velocity modulations transistor (i.e., VMT) (EPO)
E29.245 .....With one-dimensional charge carrier gas channel (e.g., quantum wire FET) (EPO)
E29.246 .....With two-dimensional charge carrier gas channel (e.g,. HEMT; with two-dimensional charge-carrier layer formed at heterojunction interface) (EPO)
E29.247 ......With inverted single heterostructure (i.e., with active layer formed on top of wide bandgap layer (e.g., IHEMT)) (EPO)
E29.248 ......With confinement of carriers by at least two heterojunctions (e.g., DHHEMT, quantum well HEMT, DHMODFET) (EPO)
E29.249 .....Using Group III-V semiconductor material (EPO)
E29.25 .....With more than one donor layer (EPO)
E29.251 .....With delta or planar doped donor layer (EPO)
E29.252 ......With direct single heterostructure (i.e., with wide bandgap layer formed on top of active layer (e.g., direct single heterostruture MIS-like HEMT)) (EPO)
E29.253 .....With wide bandgap charge-carrier supplying layer (e.g., direct single heterostructure MODFET) (EPO)
E29.254 .....With delta-doped channel (EPO)
E29.255 .....With field effect produced by insulated gate (EPO)
E29.256 ......With channel containing layer contacting drain drift region (e.g., DMOS transistor) (EPO)
E29.257 .....Having a vertical bulk current component or current vertically following a trench gate, (e.g., vertical power DMOS transistor) (EPO)
E29.258 .....With both source and drain contacts in same substrate side (EPO)
E29.259 .....With nonplanar surface (EPO)
E29.26 .....Channel structure lying under slanted or vertical surface or being formed along surface of groove (e.g., trench gate DMOSFET) (EPO)
E29.261 .....With at least part of active region on insulating substrate (e.g., lateral DMOS in oxide isolated well) (EPO)
E29.262 ......Vertical transistor (EPO)
E29.263 ......Comprising gate to body connection (i.e., bulk dynamic threshold voltage MOSFET) (EPO)
E29.264 ......With multiple gate structure (EPO)
E29.265 .....Structure comprising MOS gate and at least one non-MOS gate (e.g., JFET or MESFET gate) (EPO)
E29.266 ......With lightly doped drain or source extension (EPO)
E29.267 .....With nonplanar structure (e.g., gate or source or drain being nonplanar) (EPO)
E29.268 .....The source region and drain region having a non-symmetrical structure about the gate electrode (EPO)
E29.269 .....With overlap between lightly doped extension and gate electrode (EPO)
E29.27 ......With buried channel (EPO)
E29.271 ......With Schottky drain or source contact (EPO)
E29.272 ......Gate comprising ferroelectric layer (EPO)
E29.273 ......Thin film transistor (EPO)
E29.274 .....Vertical transistor (EPO)
E29.275 .....With multiple gates (EPO)
E29.276 .....With supplementary region or layer in thin film or in insulated bulk substrate supporting it for controlling or increasing voltage resistance of device (EPO)

E29.277 .....Characterized by drain or source properties (EPO)
E29.278 .....With LDD structure or extension or offset region or characterized by doping profile (EPO)
E29.279 .....Asymmetrical source and drain regions (EPO)
E29.28 .....For preventing leakage current (EPO)
E29.281 .....For preventing kink or snapback effect (e.g., discharging minority carriers of channel region for preventing bipolar effect) (EPO)
E29.282 .....With light shield (EPO)
E29.283 .....With supplementary region or layer for improving flatness of device (EPO)
E29.284 .....With drain or source connected to bulk conducting substrate (EPO)
E29.285 .....Silicon transistor (EPO)
E29.286 .....Monocrystalline only (EPO)
E29.287 .....SOS transistor (EPO)
E29.288 .....Nonmonocrystalline (EPO)
E29.289 .....Amorphous silicon transistor (EPO)
E29.29 .....With top gate (EPO)
E29.291 .....With inverted transistor structure (EPO)
E29.292 .....Polycrystalline or microcrystalline silicon transistor (EPO)
E29.293 .....With top gate (EPO)
E29.294 .....With inverted transistor structure (EPO)
E29.295 .....Characterized by insulating substrate or support (EPO)
E29.296 .....Comprising Group III-V or II-VI compound, or of Se, Te, or oxide semiconductor (EPO)
E29.297 .....Comprising Group IV non-Si semiconductor materials or alloys (e.g., Ge, SiN alloy, SiC alloy) (EPO)
E29.298 .....With multilayer structure or superlattice structure (EPO)
E29.299 .....Characterized by property or structure of channel or contact thereto (EPO)
E29.3 .....With floating gate (EPO)
E29.301 .....Programmable by two single electrons (EPO)
E29.302 .....Hi-lo programming levels only (EPO)
E29.303 .....Charging by injection of carriers through conductive insulator (e.g., Poole-Frankel conduction) (EPO)
E29.304 .....Charging by tunneling of carriers, (e.g. Fowler-Nordheim tunneling) (EPO)
E29.305 .....Charging by hot carrier injection (EPO)
E29.306 .....Hot carrier injection from channel (EPO)
E29.307 .....Hot carrier produced by avalanche breakdown of PN junction (e.g., FAMOS) (EPO)
E29.308 .....Programmable with more than two possible different levels (EPO)
E29.309 .....With charge trapping gate insulator (e.g., MNOS-memory transistors) (EPO)
E29.31 .....With field effect produced by PN or other rectifying junction gate (i.e., potential-jump barrier) (EPO)
E29.311 .....With Schottky drain or source contact (EPO)
E29.312 .....With PN junction gate (e.g., PN homojunction gate) (EPO)
E29.313 .....Vertical transistors (EPO)
E29.314 .....Thin film JFET (EPO)
E29.315 .....With heterojunction gate (e.g., transistors with semiconductor layer acting as gate insulating layer) (EPO)
E29.316 .....Programmable transistor (e.g., with charge-trapping quantum well) (EPO)
E29.317 .....With Schottky gate (EPO)
E29.318 .....Vertical transistors (EPO)
E29.319 .....With multiple gate (EPO)
E29.32 .....Thin film MESFET (EPO)
E29.321 .....With recessed gate (EPO)
E29.322 ....Single electron transistors: Coulomb blockade device (EPO)
E29.323 ..Controllable by variation of magnetic field applied to device (EPO)

E29.324 ..Controllable by variation of applied mechanical force (e.g., of pressure) (EPO)
E29.325 ..Controllable only by variation of electric current supplied or only electric potential applied to electrode carrying current to be rectified, amplified, oscillated, or switched (EPO)
E29.326 ...Resistor with PN junction (EPO)
E29.327 ...Diode (EPO)
E29.328 ....Planar PN junction diode (EPO)
E29.329 ....Mesa PN junction diode (EPO)
E29.33 ....Hi-lo semiconductor device (e.g., memory device) (EPO)
E29.331 ....Charge trapping diode (EPO)
E29.332 ....Punchthrough diode (i.e., with bulk potential barrier (e.g., camel diode, planar doped barrier diode, graded bandgap diode)) (EPO)
E29.333 ....Point contact diode (EPO)
E29.334 ....Transit-time diode (e.g., IMPATT, TRAPATT diode) (EPO)
E29.335 ....Avalanche diode (e.g., Zener diode) (EPO)
E29.336 ....PIN diode (EPO)
E29.337 ....Thyristor diode (i.e., having only two terminals and no control (gate) electrode (e.g., Shockley diode, break-over diode)) (EPO)
E29.338 ....Schottky diode (EPO)
E29.339 ....Tunneling diode (EPO)
E29.34 .....Resonant tunneling diode (i.e., RTD, RTBD) (EPO)
E29.341 .....Esaki diode (EPO)
E29.342 ...Capacitor with potential-jump barrier or surface barrier (EPO)
E29.343 ....Conductor-insulator-conductor capacitor on semiconductor substrate (EPO)
E29.344 ....Variable capacitance diode (e.g., varactors) (EPO)
E29.345 ....Metal-insulator-semiconductor (e.g., MOS capacitor) (EPO)
E29.346 .....Trench capacitor (EPO)
E29.347 ..Controllable by thermal signal (e.g., IR) (EPO)

E27.001 **DEVICE CONSISTING OF A PLURALITY OF SEMICONDUCTOR OR OTHER SOLID STATE COMPONENTS FORMED IN OR ON A COMMON SUBSTRATE, E.G., INTEGRATED CIRCUIT DEVICE (EPO)**
E27.002 .Including bulk negative resistance effect component (EPO)
E27.003 ..Including Gunn-effect device (EPO)
E27.004 .Including solid state component for rectifying, amplifying, or switching without a potential barrier or surface barrier (EPO)
E27.005 .Including component using galvano-magnetic effects, e.g., Hall effect (EPO)
E27.006 .Including piezo-electric, electro-resistive, or magneto-resistive component (EPO)
E27.007 .Including superconducting component (EPO)
E27.008 .Including thermo-electric or thermo-magnetic component with or without a junction of dissimilar material or thermo-magnetic component (EPO)
E27.009 .Including semiconductor component with at least one potential barrier or surface barrier adapted for rectifying, oscillating, amplifying, or switching, or including integrated passive circuit elements (EPO)
E27.01 ..With semiconductor substrate only (EPO)
E27.011 ...Including a plurality of components in a non-repetitive configuration (EPO)
E27.012 ....Made of compound semiconductor material, e.g. III-V material (EPO)
E27.013 ....Integrated circuit having a two-dimensional layout of components without a common active region (EPO)
E27.014 .....Including a field-effect type component (EPO)
E27.015 ......In combination with bipolar transistor (EPO)
E27.016 ......In combination with diode, resistor, or capacitor (EPO)

E27.017 ......In combination with bipolar transistor and diode, resistor, or capacitor (EPO)
E27.018 .....With component other than field-effect type (EPO)
E27.019 ......Bipolar transistor in combination with diode, capacitor, or resistor (EPO)
E27.02 ....Vertical bipolar transistor in combination with diode, capacitor, or resistor (EPO)
E27.021 ....Vertical bipolar transistor in combination with resistor or capacitor only (EPO)
E27.022 ....Vertical bipolar transistor in combination with diode only (EPO)
E27.023 ....Lateral bipolar transistor in combination with diode, capacitor, or resistor (EPO)
E27.024 ......Including combination of diode, capacitor, or resistor (EPO)
E27.025 ....Including combination of capacitor or resistor only (EPO)
E27.026 ....Integrated circuit having a three-dimensional layout (EPO)
E27.027 .....Including components formed on opposite sides of a semiconductor substrate (EPO)
E27.028 ....Including component having an active region in common (EPO)
E27.029 .....Including component of the field effect type (EPO)
E27.03 ......In combination with bipolar transistor and diode, capacitor, or resistor (EPO)
E27.031 ....In combination with vertical bipolar transistor and diode, capacitor, or resistor (EPO)
E27.032 ....In combination with lateral bipolar transistor and diode, capacitor, or resistor (EPO)
E27.033 ......In combination with diode, capacitor, or resistor (EPO)
E27.034 ....In combination with capacitor only (EPO)
E27.035 ....In combination with resistor only (EPO)
E27.036 .....With component other than field effect type (EPO)
E27.037 ......Bipolar transistor in combination with diode, capacitor, or resistor (EPO)
E27.038 ....Vertical bipolar transistor in combination with diode, capacitor, or resistor (EPO)
E27.039 ....Vertical bipolar transistor in combination with diode only (EPO)
E27.04 ....With Schottky diode only (EPO)
E27.041 ....Vertical bipolar transistor in combination with resistor only (EPO)
E27.042 ....Vertical bipolar transistor in combination with capacitor only (EPO)
E27.043 ....Lateral bipolar transistor in combination with diode, capacitor, or resistor (EPO)
E27.044 ......Including combination of diode, capacitor, or resistor (EPO)
E27.045 ....Combination of capacitor and resistor (EPO)
E27.046 ...Including only semiconductor components of a single kind, e.g., all bipolar transistors, all diodes, or all CMOS (EPO)
E27.047 ....Resistor only (EPO)
E27.048 ....Capacitor only (EPO)
E27.049 .....Varactor diode (EPO)
E27.05 .....Metal-insulated-semiconductor (MIS) diode (EPO)
E27.051 ....Diode only (EPO)
E27.052 ....Thyristor only (EPO)
E27.053 ....Bipolar component only (EPO)
E27.054 .....Combination of lateral and vertical transistors only (EPO)
E27.055 .....Vertical bipolar transistor only (EPO)
E27.056 ......Vertical direct transistor of the same conductivity type having different characteristics, (e.g., Darlington transistor) (EPO)
E27.057 ......Vertical complementary transistor (EPO)

E27.058 ......Combination of direct and inverse vertical transistors (e.g., collector acts as emitter) (EPO)
E27.059 ....Including field-effect component only (EPO)
E27.06 .....Field-effect transistor with insulated gate (EPO)
E27.061 ......Combination of depletion and enhancement field-effect transistors (EPO)
E27.062 ......Complementary MIS (EPO)
E27.063 ....Means for preventing a parasitic bipolar action between the different transistor regions, e.g., latch-up prevention (EPO)
E27.064 ....Combination of complementary transistors having a different structure, e.g., stacked CMOS, high-voltage and low-voltage CMOS (EPO)
E27.065 ....Including an N-well only in the substrate (EPO)
E27.066 ....Including a P-well only in the substrate (EPO)
E27.067 ....Including both N- and P-wells in the substrate, e.g., twin-tub (EPO)
E27.068 .....Schottky barrier gate field-effect transistor (EPO)
E27.069 .....PN junction gate field-effect transistor (EPO)
E27.07 ...Including a plurality of individual components in a repetitive configuration (EPO)
E27.071 ....Including resistor or capacitor only (EPO)
E27.072 ....Including bipolar component (EPO)
E27.073 .....Including diode only (EPO)
E27.074 .....Including bipolar transistor (EPO)
E27.075 ......Bipolar dynamic random access memory structure (EPO)
E27.076 ......Array of single bipolar transistors only, e.g., read only memory structure (EPO)
E27.077 ......Static bipolar memory cell structure (EPO)
E27.078 ......Bipolar electrically programmable memory structure (EPO)
E27.079 .....Thyristor (EPO)
E27.08 .....Unijunction transistor, i.e., three terminal device with only one p-n junction having a negative resistance region in the I-V characteristic (EPO)
E27.081 ....Including field-effect component (EPO)
E27.082 .....Including bucket brigade type charge coupled device (C.C.D) (EPO)
E27.083 .....Including charge coupled device (C.C.D) or charge injection device (C.I.D) (EPO)
E27.084 .....Dynamic random access memory, DRAM, structure (EPO)
E27.085 ......One-transistor memory cell structure, i.e., each memory cell containing only one transistor (EPO)
E27.086 ....Storage electrode stacked over the transistor (EPO)
E27.087 ....With bit line higher than capacitor (EPO)
E27.088 ....With capacitor higher than bit line level (EPO)
E27.089 ....Storage electrode having multiple wings (EPO)
E27.09 ....Capacitor extending under the transistor (EPO)
E27.091 ....Transistor in trench (EPO)
E27.092 ....Capacitor in trench (EPO)
E27.093 ....Capacitor extending under or around the transistor (EPO)
E27.094 ....Having storage electrode extension stacked over the transistor (EPO)
E27.095 ....Capacitor and transistor in common trench (EPO)
E27.096 ....Vertical transistor (EPO)
E27.097 ......Peripheral structure (EPO)
E27.098 .....Static random access memory, SRAM, structure (EPO)
E27.099 ......Load element being a MOSFET transistor (EPO)
E27.1 ....Load element being a thin film transistor (EPO)
E27.101 ......Load element being a resistor (EPO)
E27.102 .....Read-only memory, ROM, structure (EPO)
E27.103 ......Electrically programmable ROM (EPO)
E27.104 ....Ferroelectric non-volatile memory structure (EPO)

E27.105 ....Masterslice integrated circuit (EPO)
E27.106 .....Using bipolar structure (EPO)
E27.107 .....Using field effect structure (EPO)
E27.108 ......CMOS gate array (EPO)
E27.109 .....Using combined field effect/ bipolar structure (EPO)
E27.11 .....Input and output buffer/ driver (EPO)
E27.111 ..Substrate comprising other than a semiconductor material, e.g., insulating substrate or layered substrate including a non-semiconductor layer (EPO)
E27.112 ...Including insulator on semiconductor, e.g., SOI (silicon on insulator) (EPO)
E27.113 ...Combined with thin-film or thick-film passive component (EPO)
E27.114 .Including only passive thin-film or thick-film elements on a common insulating substrate (EPO)
E27.115 ..Thick-film circuits (EPO)
E27.116 ..Thin-film circuits (EPO)
E27.117 .Including organic material in active region (EPO)
E27.118 ..Including semiconductor components sensitive to infrared radiation, light, or electromagnetic radiation of a shorter wavelength (EPO)
E27.119 ..Including semiconductor components with at least one potential barrier, surface barrier, or recombination zone adapted for light emission (EPO)
E27.12 .Including semiconductor component with at least one potential barrier or surface barrier adapted for light emission structurally associated with controlling devices having a variable impedance and not being light sensitive (EPO)
E27.121 ..In a repetitive configuration (EPO)
E27.122 .Including active semiconductor component sensitive to infrared radiation, light, or electromagnetic radiation of a shorter wavelength (EPO)
E27.123 ..Energy conversion device (EPO)
E27.124 ...In a repetitive configuration, e.g., planar multi-junction solar cells (EPO)
E27.125 ....Including only thin film solar cells deposited on a substrate (EPO)
E27.126 ....Including multiple vertical junction or V-groove junction solar cells formed in a semiconductor substrate (EPO)
E27.127 ..Device controlled by radiation (EPO)
E27.128 ...With at least one potential barrier or surface barrier (EPO)
E27.129 ....In a repetitive configuration (EPO)
E27.13 ...Imager including structural or functional details of the device (EPO)
E27.131 ....Geometry or disposition of pixel-elements, address-lines, or gate-electrodes (EPO)
E27.132 ....Pixel-elements with integrated switching, control, storage, or amplification elements (EPO)
E27.133 ....Photodiode array or MOS imager (EPO)
E27.134 .....Color imager (EPO)
E27.135 ......Multicolor imager having a stacked pixel-element structure, e.g., npn, npnpn or MQW elements
E27.136 .....Infrared imager (EPO)
E27.137 ......Of the hybrid type (e.g., chip-on-chip, bonded substrates) (EPO)
E27.138 ......Multispectral infrared imager having a stacked pixel-element structure, e.g., npn, npnpn or MQW structures (EPO)
E27.139 .....Anti-blooming (EPO)
E27.14 .....X-ray, gamma-ray, or high energy radiation imager (measuring X-, gamma- or corpuscular radiation (EPO)

E27.141 ....Imager using a photoconductor layer (e.g., single photoconductor layer for all pixels) (EPO)
E27.142 .....Color imager (EPO)
E27.143 .....Infrared imager (EPO)
E27.144 ......Of the hybrid type (e.g., chip-on-chip, bonded substrates) (EPO)
E27.145 .....Anti-blooming (EPO)
E27.146 .....X-ray, gamma-ray, or high energy radiation imagers (EPO)
E27.147 ....Contact-type imager (e.g., contacts document surface) (EPO)
E27.148 ....Junction field effect transistor (JFET) imager or static induction transistor (SIT) imager (EPO)
E27.149 ....Bipolar transistor imager (EPO)
E27.15 ....Charge coupled imager (EPO)
E27.151 .....Structural or functional details (EPO)
E27.152 ......Geometry or disposition of pixel-elements, address lines or gate-electrodes (EPO)
E27.153 .....Linear CCD imager (EPO)
E27.154 .....Area CCD imager (EPO)
E27.155 ......Frame-interline transfer (EPO)
E27.156 ......Interline transfer (EPO)
E27.157 ......Frame transfer (EPO)
E27.158 .....CID imager (charge injection device) (EPO)
E27.159 .....CCD or CID color imager (EPO)
E27.16 .....Infrared CCD or CID imager (EPO)
E27.161 ......Of the hybrid type (e.g., chip-on-chip, bonded substrates) (EPO)
E27.162 .....Anti-blooming (EPO)
E27.163 .....Including a photoconductive layer deposited on the CCD structure (EPO)
E51.001 **ORGANIC SOLID-STATE DEVICE (EPO)**
E51.002 .Structural detail of device (EPO)
E51.003 ..Organic solid-state device adapted for rectifying, amplifying, oscillating, or switching, or capacitors or resistors with potential or surface barrier (EPO)
E51.004 ...Controllable by only signal applied to control electrode (e.g., base of bipolar transistor, gate of field-effect transistor) (EPO)
E51.005 ....Field-effect device (e.g., TFT, FET) (EPO)
E51.006 .....Insulated gate field-effect transistor (EPO)
E51.007 ......Comprising organic gate dielectric (EPO)
E51.008 ...Controllable only by variation of electric current supplied or only electric potential applied to electrode carrying current to be rectified, amplified, oscillated, or switched (e.g., two terminal device) (EPO)
E51.009 ....Comprising Schottky junction (EPO)
E51.01 ....Comprising organic/organic junction (e.g., heterojunction) (EPO)
E51.011 ....Comprising organic/inorganic heterojunction (EPO)
E51.012 ..Radiation-sensitive organic solid-state device (EPO)
E51.013 ...Metal-organic semiconductor-metal device (EPO)
E51.014 ...Comprising bulk heterojunction (EPO)
E51.015 ...Comprising organic/inorganic heterojunction (EPO)
E51.016 ....Majority carrier device using sensitization of wide band gap semiconductor (e.g., TiO2) (EPO)
E51.017 ...Comprising organic semiconductor-organic semiconductor heterojunction (EPO)
E51.018 ..Light-emitting organic solid-state device with potential or surface barrier (EPO)
E51.019 ...Electrode (EPO)
E51.02 ....Encapsulation (EPO)
E51.021 ....Arrangements for extracting light from device (e.g., Bragg reflector pair) (EPO)
E51.022 ...Multicolor organic light-emitting device (OLED) (EPO)
E51.023 ..Molecular electronic device (EPO)

E51.024 .Selection of material for organic solid-state device (EPO)
E51.025 ..For organic solid-state device adapted for rectifying, amplifying, oscillating, or switching, or capacitors or resistors with potential or surface barrier (EPO)
E51.026 ..For radiation-sensitive or light-emitting organic solid-state device with potential or surface barrier (EPO)
E51.027 ..Organic polymer or oligomer (EPO)
E51.028 ...Comprising aromatic, heteroaromatic, or arrylic chains (e.g., polyaniline, polyphenylene, polyphenylene vinylene) (EPO)
E51.029 ....Heteroaromatic compound comprising sulfur or selene (e.g., polythiophene) (EPO)
E51.03 .....Polyethylene dioxythiophene and derivative (EPO)
E51.031 ....Polyphenylenevinylene and derivatives (EPO)
E51.032 ....Polyflurorene and derivative (EPO)
E51.033 ...Comprising aliphatic or olefinic chains (e.g., polyN-vinylcarbazol, PVC, PTFE) (EPO)
E51.034 ....Polyacetylene or derivatives (EPO)
E51.035 ....PolyN-vinylcarbazol and derivative (EPO)
E51.036 ...Copolymers (EPO)
E51.037 ...Ladder-type polymer (EPO)
E51.038 ..Carbon-containing materials (EPO)
E51.039 ...Fullerenes (EPO)
E51.04 ...Carbon nanotubes (EPO)
E51.041 ..Coordination compound (e.g., porphyrin, phthalocyanine, metal(II) polypyridine complexes) (EPO)
E51.042 ...Phthalocyanine (EPO)
E51.043 ...Metal complexes comprising Group IIIB metal (Al, Ga, In, or Ti) (e.g., Tris (8-hydroxyquinoline) aluminium (Alq3)) (EPO)
E51.044 ...Transition metal complexes (e.g., Ru(II) polypyridine complexes) (EPO)
E51.045 ..Biomolecule or macromolecule (e.g., proteins, ATP, chlorophyl, beta-carotene, lipids, enzymes) (EPO)
E51.046 ..Silicon-containing organic semiconductor (EPO)
E51.047 ..Macromolecular system with low molecular weight (e.g., cyanine dyes, coumarine dyes, tetrathiafulvalene) (EPO)
E51.048 ...Charge transfer complexes (EPO)
E51.049 ...Polycondensed aromatic or heteroaromatic compound (e.g., pyrene, perylene, pentacene) (EPO)
E51.05 ....Aromatic compound containing heteroatom (e.g., perylenetetracarboxylic dianhydride, perylene tetracarboxylic diimide) (EPO)
E51.051 ...Amine compound having at least two aryl on amine-nitrogen atom (e.g., triphenylamine) (EPO)
E51.052 ..Langmuir Blodgett film (EPO)
E31.001 **SEMICONDUCTOR DEVICE RESPONSIVE OR SENSITIVE TO ELECTROMAGNETIC RADIATION (E.G., INFRARED RADIATION, ADAPTED FOR CONVERSION OF RADIATION INTO ELECTRICAL ENERGY OR FOR CONTROL OF ELECTRICAL ENERGY BY SUCH RADIATION) (EPO)**
E31.002 .Characterized by semiconductor body (EPO)
E31.003 ..Characterized by semiconductor body material (EPO)
E31.004 ...Inorganic materials (EPO)
E31.005 ....In different semiconductor regions (e.g., Cu2X/CdX heterojunction and X being Group VI element) (EPO)
E31.006 .....Comprising only Cu2X/CdX heterojunction and X being Group VI element (EPO)
E31.007 .....Comprising only heterojunction including Group I-III-VI compound (e.g., CdS/CuInSe2 heterojunction) (EPO)
E31.008 ....Selenium or tellurium (EPO)
E31.009 .....For device having potential or surface barrier (EPO)
E31.01 .....Characterized by doping material (EPO)

E31.011 ....Including, apart from doping material or other impurity, only Group IV element (EPO)
E31.012 .....For device having potential or surface barrier (EPO)
E31.013 .....Comprising porous silicon as part of active layer (EPO)
E31.014 .....Characterized by doping material (EPO)
E31.015 ....Including, apart from doping material or other impurity, only Group II-VI compound (e.g., CdS, ZnS, HgCdTe) (EPO)
E31.016 .....For device having potential or surface barrier (EPO)
E31.017 ......Characterized by doping material (EPO)
E31.018 .....Including ternary compound (e.g., HgCdTe) (EPO)
E31.019 ....Including, apart from doping material or other impurity, only Group III-V compound (EPO)
E31.02 .....For device having potential or surface barrier (EPO)
E31.021 ......Characterized by doping material GaAlAs, InGaAs, InGaAsP (EPO)
E31.022 .....Including ternary or quaternary compound (EPO)
E31.023 ....Including, apart from doping material or other impurity, only Group IV compound (e.g., SiC) (EPO)
E31.024 .....For device having potential or surface barrier (EPO)
E31.025 .....Characterized by doping material (EPO)
E31.026 ....Including, apart from doping material or other impurity, only compound other than Group II-VI, III-V, and IV compound (EPO)
E31.027 .....Comprising only Group I-III-VI chalcopyrite compound (e.g., CuInSe2, CuGaSe2, CuInGaSe2) (EPO)
E31.028 ......Characterized by doping material (EPO)
E31.029 .....Comprising only Group IV-VI or II-IV-VI chalcogenide compound (e.g., PbSnTe) (EPO)
E31.03 ......Characterized by doping material (EPO)
E31.031 .....Characterized by doping material (EPO)
E31.032 ..Characterized by semiconductor body shape, relative size, or disposition of semiconductor regions (EPO)
E31.033 ...Multiple quantum well structure (EPO)
E31.034 ....Characterized by amorphous semiconductor layer (EPO)
E31.035 ....Including, apart from doping material or other impurity, only Group IV element or compound (e.g., Si-SiGe superlattice) (EPO)
E31.036 ....Doping superlattice (e.g., nipi superlattice) (EPO)
E31.037 ...For device having potential or surface barrier (EPO)
E31.038 ....Shape of body (EPO)
E31.039 ....Shape of potential or surface barrier (EPO)
E31.04 ..Characterized by semiconductor body crystalline structure or plane (EPO)
E31.041 ...Including thin film deposited on metallic or insulating substrate (EPO)
E31.042 ....Including only Group IV element (EPO)
E31.043 ...Including polycrystalline semiconductor (EPO)
E31.044 ....Including only Group IV element (EPO)
E31.045 .....Including microcrystalline silicon (Tc-Si) (EPO)
E31.046 .....Including microcrystalline Group IV compound (e.g., Tc-SiGe, Tc-SiC) (EPO)
E31.047 ...Including amorphous semiconductor (EPO)
E31.048 ....Including only Group IV element (EPO)
E31.049 .....Including Group IV compound (e.g., SiGe, SiC) (EPO)
E31.05 .....Having light-induced characteristic variation (e.g., Staebler-Wronski effect) (EPO)
E31.051 ...Including other nonmonocrystalline material (e.g., semiconductor particles embedded in insulating material) (EPO)

E31.052 .Adapted to control current flow through device (e.g., photoresistor) (EPO)
E31.053 ..For device having potential or surface barrier (e.g., phototransistor) (EPO)
E31.054 ...Device sensitive to infrared, visible, or ultraviolet radiation (EPO)
E31.055 ....Characterized by only one potential or surface barrier (EPO)
E31.056 .....Potential barrier being of point contact type (EPO)
E31.057 .....PN homojunction potential barrier (EPO)
E31.058 ......Device comprising active layer formed only by Group II-VI compound (e.g., HgCdTe IR photodiode) (EPO)
E31.059 ......Device comprising active layer formed only by Group III-V compound (EPO)
E31.06 ......Device comprising active layer formed only by Group IV compound (EPO)
E31.061 .....PIN potential barrier (EPO)
E31.062 ......Device comprising Group IV amorphous material (EPO)
E31.063 .....Potential barrier working in avalanche mode (e.g., avalanche photodiode) (EPO)
E31.064 ......Heterostructure (e.g., surface absorption or multiplication (SAM) layer) (EPO)
E31.065 .....Schottky potential barrier (EPO)
E31.066 ......Metal-semiconductor-metal (MSM) Schottky barrier (EPO)
E31.067 .....PN heterojunction potential barrier (EPO)
E31.068 ....Characterized by two potential or surface barriers (EPO)
E31.069 .....Bipolar phototransistor (EPO)
E31.07 ....Characterized by at least three potential barriers (EPO)
E31.071 .....Photothyristor (EPO)
E31.072 ......Static induction type (i.e., SIT device) (EPO)
E31.073 ....Field effect type (e.g., junction field-effect phototransistor) (EPO)
E31.074 .....With Schottky gate (EPO)
E31.075 ......Charge-coupled device (CCD) (EPO)
E31.076 ......Photo MESFET (EPO)
E31.077 .....With PN homojunction gate (EPO)
E31.078 ......Charge-coupled device (CCD) (EPO)
E31.079 ......Field-effect phototransistor (EPO)
E31.08 .....With PN heterojunction gate (EPO)
E31.081 ......Charge-coupled device (CCD) (EPO)
E31.082 ......Field-effect phototransistor (EPO)
E31.083 .....Conductor-insulator-semiconductor type (EPO)
E31.084 ......Diode or charge-coupled device (CCD) (EPO)
E31.085 ......Metal-insulator-semiconductor field-effect transistor (EPO)
E31.086 ...Device sensitive to very short wavelength (e.g., X-ray, gamma-ray, or corpuscular radiation) (EPO)
E31.087 ....Bulk-effect radiation detector (e.g., Ge-Li compensated PIN gamma-ray detector) (EPO)
E31.088 .....Li-compensated PIN gamma-ray detector (EPO)
E31.089 ....With surface barrier or shallow PN junction (e.g., surface barrier alpha-particle detector) (EPO)
E31.09 .....With shallow PN junction (EPO)
E31.091 ....Field effect type (e.g., MIS-type detector) (EPO)
E31.092 ..Device being sensitive to very short wavelength (e.g., X-ray, gamma-ray) (EPO)
E31.093 ..Device sensitive to infrared, visible, or ultraviolet radiation (EPO)
E31.094 ...Comprising amorphous semiconductor (EPO)
E31.095 .Structurally associated with electric light source (e.g., electroluminescent light source) (EPO)

E31.096 ..Hybrid device containing photosensitive and electroluminescent components within one single body (EPO)
E31.097 ..Light source controlled by radiation-sensitive semiconductor device (e.g., image converter, image amplifier, image storage device) (EPO)
E31.098 ...Device without potential or surface barrier (EPO)
E31.099 ....Light source being semiconductor device with potential or surface barrier (e.g., light-emitting diode) (EPO)
E31.1 ...Device with potential or surface barrier (EPO)
E31.101 ...Semiconductor light source and radiation-sensitive semiconductor device both having potential or surface barrier (EPO)
E31.102 ....Formed in or on common substrate (EPO)
E31.103 ..Radiation-sensitive semiconductor device controlled by light source (EPO)
E31.104 ...Radiation-sensitive semiconductor device without potential or surface barrier (e.g., photoresistor) (EPO)
E31.105 ....Light source being semiconductor device having potential or surface barrier (e.g., light-emitting diode) (EPO)
E31.106 ....Optical potentiometer (EPO)
E31.107 ...Radiation-sensitive semiconductor device with potential or surface barrier (EPO)
E31.108 ...Semiconductor light source and radiation-sensitive semiconductor device both having potential or surface barrier (EPO)
E31.109 ....Formed in or on common substrate (EPO)
E31.11 .Detail of nonsemiconductor component of radiation-sensitive semiconductor device (EPO)
E31.111 ..Input/output circuit of device (EPO)
E31.112 ...For device having potential or surface barrier (EPO)
E31.113 ..Circuit arrangement of general character for device (EPO)
E31.114 ...For device having potential or surface barrier (EPO)
E31.115 ....Position-sensitive and lateral-effect photodetector (e.g., quadrant photodiode) (EPO)
E31.116 ....Device working in avalanche mode (EPO)
E31.117 ..Encapsulation (EPO)
E31.118 ...For device having potential or surface barrier (EPO)
E31.119 ..Coatings (EPO)
E31.12 ...For device having potential or surface barrier (EPO)
E31.121 ....For filtering or shielding light (e.g., multicolor filter for photodetector) (EPO)
E31.122 .....For shielding light (e.g., light-blocking layer, cold shield for infrared detector) (EPO)
E31.123 .....For interference filter (e.g., multilayer dielectric filter) (EPO)
E31.124 ..Electrode (EPO)
E31.125 ...For device having potential or surface barrier (EPO)
E31.126 ...Transparent conductive layer (e.g., transparent conductive oxide (TCO), indium tin oxide (ITO) layer) (EPO)
E31.127 ..Optical element associated with device (EPO)
E31.128 ...Device having potential or surface barrier (EPO)
E31.129 ...Comprising luminescent member (e.g., fluorescent sheet) (EPO)
E31.13 ..Texturized surface (EPO)
E31.131 ..Arrangement for temperature regulation (e.g., cooling, heating, or ventilating) (EPO)
E33.001 **LIGHT-EMITTING SEMICONDUCTOR DEVICE HAVING POTENTIAL OR SURFACE BARRIER (EPO)**
E33.002 .Device characterized by semiconductor body (EPO)
E33.003 ..Particular crystalline orientation or structure (EPO)

E33.004 ...Comprising amorphous semiconductor (EPO)
E33.005 ..Shape or structure (e.g., shape of epitaxial layer) (EPO)
E33.006 ...Shape of semiconductor body (EPO)
E33.007 ...Shape of potential barrier (EPO)
E33.008 ...Multiple quantum well structure (EPO)
E33.009 ....Including, apart from doping materials or other only impurities, Group IV element (e.g., Si-SiGe superlattice) (EPO)
E33.01 ....Doped superlattice (e.g., nipi superlattice) (EPO)
E33.011 ...For current confinement (EPO)
E33.012 ...Multiple active regions between two electrodes (e.g., stacks) (EPO)
E33.013 ..Material of active region (EPO)
E33.014 ...In different regions (EPO)
E33.015 ...Comprising only Group IV element (EPO)
E33.016 ....With heterojunction (EPO)
E33.017 ....Characterized by doping material (EPO)
E33.018 ....Including porous Si (EPO)
E33.019 ...Comprising only Group II-VI compound (EPO)
E33.02 ....Ternary or quaternary compound (e.g., CdHgTe) (EPO)
E33.021 .....With heterojunction (EPO)
E33.022 ....Characterized by doping material (EPO)
E33.023 ...Comprising only Group III-V compound (EPO)
E33.024 ....Binary compound (e.g., GaAs) (EPO)
E33.025 .....Including nitride (e.g., GaN) (EPO)
E33.026 ....Ternary or quaternary compound (e.g., AlGaAs) (EPO)
E33.027 .....With heterojunction (EPO)
E33.028 .....Including nitride (e.g., AlGaN) (EPO)
E33.029 ....Characterized by doping material (EPO)
E33.03 .....Nitride compound (EPO)
E33.031 ....Including ternary or quaternary compound (e.g., AlGaAs) (EPO)
E33.032 .....With heterojunction (e.g., AlGaAs/GaAs) (EPO)
E33.033 .....Comprising nitride compound (e.g., AlGaN) (EPO)
E33.034 ......With heterojunction (e.g., AlGaN/GaN) (EPO)
E33.035 ...Comprising only Group IV compound (e.g., SiC) (EPO)
E33.036 ....Characterized by doping material (EPO)
E33.037 ...Comprising compound other than Group II-VI, III-V, and IV compound (EPO)
E33.038 ....Comprising only Group IV-VI compound (EPO)
E33.039 ....Comprising only Group II-IV-VI compound (EPO)
E33.04 ....Comprising only Group I-III-VI compound (EPO)
E33.041 ....Characterized by doping material (EPO)
E33.042 ....Comprising only Group IV-VI or II-IV-VI compound (EPO)
E33.043 ..Physical imperfections (e.g., particular concentration or distribution of impurity) (EPO)
E33.044 .Device characterized by their operation (EPO)
E33.045 ..Having p-n or hi-lo junction (EPO)
E33.046 ...P-I-N device (EPO)
E33.047 ...Having at least two p-n junctions (EPO)
E33.048 ..Having heterojunction or graded gap (EPO)
E33.049 ...Comprising only Group III-V compound (EPO)
E33.05 ...Comprising only Group II-IV compound (EPO)
E33.051 ..Having Schottky barrier (EPO)
E33.052 ..Having MIS barrier layer (EPO)
E33.053 ..Characterized by field-effect operation (EPO)
E33.054 ..Device being superluminescent diode (EPO)
E33.055 .Detail of nonsemiconductor component other than light-emitting semiconductor device (EPO)
E33.056 ..Packaging (EPO)
E33.057 ...Adapted for surface mounting (EPO)
E33.058 ...Housing (EPO)
E33.059 ...Encapsulation (EPO)
E33.06 ..Coatings (EPO)

E33.061 ...Comprising luminescent material (e.g., fluorescent) (EPO)
E33.062 ..Electrodes (EPO)
E33.063 ...Characterized by material (EPO)
E33.064 ....Comprising transparent conductive layers (e.g., transparent conductive oxides (TCO), indium tin oxide (ITO)) (EPO)
E33.065 ...Characterized by shape (EPO)
E33.066 ..Electrical contact or lead (e.g., lead frame) (EPO)
E33.067 ..Means for light extraction or guiding (EPO)
E33.068 ...Integrated with device (e.g., back surface reflector, lens) (EPO)
E33.069 ....Comprising resonant cavity structure (e.g., Bragg reflector pair) (EPO)
E33.07 ....Comprising window layer (EPO)
E33.071 ...Not integrated with device (EPO)
E33.072 ....Reflective means (EPO)
E33.073 ....Refractive means (e.g., lens) (EPO)
E33.074 ...Scattering means (e.g., surface roughening) (EPO)
E33.075 ..With means for cooling or heating (EPO)
E33.076 ..With means for light detecting (e.g., photodetector) (EPO)
E33.077 ..Monolithic integration with photosensitive device (EPO)

CROSS-REFERENCE ART COLLECTIONS

900 **MOSFET TYPE GATE SIDEWALL INSULATING SPACER**
901 **MOSFET SUBSTRATE BIAS**
902 **FET WITH METAL SOURCE REGION**
903 **FET CONFIGURATION ADAPTED FOR USE AS STATIC MEMORY CELL**
904 .With passive components (e.g., polysilicon resistors)
905 **PLURAL DRAM CELLS SHARE COMMON CONTACT OR COMMON TRENCH**
906 **DRAM WITH CAPACITOR ELECTRODES USED FOR ACCESSING (E.G., BIT LINE IS CAPACITOR PLATE)**
907 **FOLDED BIT LINE DRAM CONFIGURATION**
908 **DRAM CONFIGURATION WITH TRANSISTORS AND CAPACITORS OF PAIRS OF CELLS ALONG A STRAIGHT LINE BETWEEN ADJACENT BIT LINES**
909 **MACROCELL ARRAYS (E.G., GATE ARRAYS WITH VARIABLE SIZE OR CONFIGURATION OF CELLS)**
910 **DIODE ARRAYS (E.G., DIODE READ-ONLY MEMORY ARRAY)**
911 **LIGHT SENSITIVE ARRAY ADAPTED TO BE SCANNED BY ELECTRON BEAM (E.G., VIDICON DEVICE)**
912 **CHARGE TRANSFER DEVICE USING BOTH ELECTRON AND HOLE SIGNAL CARRIERS**
913 **WITH MEANS TO ABSORB OR LOCALIZE UNWANTED IMPURITIES OR DEFECTS FROM SEMICONDUCTORS (E.G., HEAVY METAL GETTERING)**
914 **POLYSILICON CONTAINING OXYGEN, NITROGEN, OR CARBON (E.G., SIPOS)**
915 **WITH TITANIUM NITRIDE PORTION OR REGION**
916 **NARROW BAND GAP SEMICONDUCTOR MATERIAL (<< 1EV)**
917 **PLURAL DOPANTS OF SAME CONDUCTIVITY TYPE IN SAME REGION**
918 **LIGHT EMITTING REGENERATIVE SWITCHING DEVICE (E.G., LIGHT EMITTING SCR) ARRAYS, CIRCUITRY, ETC.**
919 **ELEMENTS OF SIMILAR CONSTRUCTION CONNECTED IN SERIES OR PARALLEL TO AVERAGE OUT MANUFACTURING VARIATIONS IN CHARACTERISTICS**
920 **CONDUCTOR LAYERS ON DIFFERENT LEVELS CONNECTED IN PARALLEL (E.G., TO REDUCE RESISTANCE)**
921 **RADIATION HARDENED SEMICONDUCTOR DEVICE**
922 **WITH MEANS TO PREVENT INSPECTION OF OR TAMPERING WITH AN INTEGRATED CIRCUIT (E.G., "SMART CARD" ANTI-TAMPER)**
923 **WITH MEANS TO OPTIMIZE ELECTRICAL CONDUCTOR CURRENT CARRYING CAPACITY (E.G., PARTICULAR CONDUCTOR ASPECT RATIO)**
924 **WITH PASSIVE DEVICE (E.G., CAPACITOR), OR BATTERY AS INTEGRAL PART OF HOUSING OR HOUSING ELEMENT (E.G., CAP)**

925 **BRIDGE RECTIFIER MODULE**
926 **ELONGATED LEAD EXTENDING AXIALLY THROUGH ANOTHER ELONGATED LEAD**
927 **DIFFERENT DOPING LEVELS IN DIFFERENT PARTS OF PN JUNCTION TO PRODUCE SHAPED DEPLETION LAYER**
928 **WITH SHORTED PN OR SCHOTTKY JUNCTION OTHER THAN EMITTER JUNCTION**
929 **PN JUNCTION ISOLATED INTEGRATED CIRCUIT WITH ISOLATION WALLS HAVING MINIMUM DOPANT CONCENTRATION AT INTERMEDIATE DEPTH IN EPITAXIAL LAYER (E.G., DIFFUSED FROM BOTH SURFACES OF EPITAXIAL LAYER)**
930 **THERMOELECTRIC (E.G., PELTIER EFFECT) COOLING**

FOREIGN ART COLLECTIONS

FOR 000 **CLASS-RELATED FOREIGN DOCUMENTS**